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Mechanical adjustment of the suaharo (Cereus giganteus) to varying quantities of stored water

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(WITH PLATES 3 AND 4)

Among the desert plants of the southwestern United States that are provided with a well-developed system for water-storage, certain cacti, particularly those of columnar form, are conspicuously fluted with strong ribs and corresponding furrows that extend from base to apex of the stem. This structure naturally suggests a ready adjustment of the plant, by a bellows-like action of its ribs and furrows, to changes in bulk due to varying amounts of stored water. It is obvious, however, that such an adjustment, if it satisfies the requirements of successful adaptation, must not impair the efficiency of the general mechanical system; since these plants, rising like a columnar water-tank, often to the height of 50 or 60 feet, from a narrow base, are subjected to the force of high winds from every point of the compass.

To ascertain whether this bellows-like action actually takes place, a series of measurements and observations were undertaken at the Desert Laboratory during the winter of 1903–4. These were begun by the resident investigator, Dr. W. A. Cannon, and, at his suggestion, were afterwards carried out and extended by myself.

An inspection of a cross-section of the stem of a giant cactus will show a heavy band of thick-walled subepidermal tissue, which is exceedingly strong and elastic. Beneath this is a band of thin-walled chlorophyl-cells, and all the tissue between this and the

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ring of fibro-vascular bundles is made up of thin-walled water-storing cells.

From the construction it seems evident that a change in bulk corresponding to varying quantities of water contained in this tissue could hardly affect the central mechanical cylinder; but would be far more likely to manifest itself externally by expansion or contraction of the circumference, effected by folding or unfolding of the ribs and furrows.

To determine whether this actually takes place, measurements were made by marking with India ink points opposite each other on adjacent ribs, and, by means of callipers, measuring the distance between them at intervals of a day or more. Opposite points at the bases of the ribs were also marked in the same way, and the thickness of the ribs between these points measured by callipers. Finally a wire was placed around some of the plants, with a coiled spring, partially stretched, inserted between its ends. Variation in the length of the spring thus indicated any change that took place in the circumference. It was found that these three sets of measurements always corresponded. The ribs and furrows expanded and contracted at the same time, and their action was coincident with a corresponding increase or decrease in the circumference. For the sake of convenience, the comparisons which follow will be restricted to the measurements of the furrows.

To exhibit their changes graphically, curves were constructed, distances between ribs being laid off on the vertical axis, each space representing $\frac{1}{64}$ inch, and time being represented on the horizontal axis, each space representing one day. (In the accompanying diagrams every fifth line only is shown, so that each vertical space represents $\frac{5}{64}$ inch, and each horizontal space 5 days.) The English instead of the metric scale was employed, merely because the finest rule available at the time was in the former system. The measurements were all made with blunt callipers, and often when the cacti were swaying in the wind, so that absolute accuracy to $\frac{1}{64}$ of an inch was not always attainable; for all the comparisons made, however, it is believed that the curves are substantially correct.

The changes in width which the furrows exhibited will readily be understood from the curves constructed from measurements of

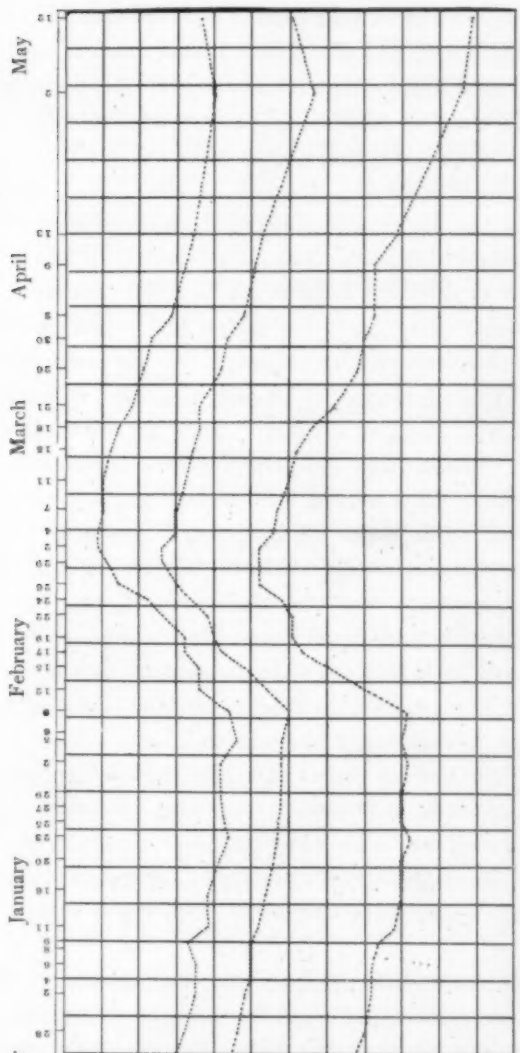

FIGURE 1. Curves derived from measurements of suaharo number 1. Rain, January 8 (0.2 in.), February 6 (0.54 in.), and May 2 (1 in.). The other days mentioned are the ones on which measurements were taken. In this and the following diagrams, each vertical space represents $\frac{8}{64}$ inch, and each horizontal space 5 days.

suaharo number 1 (*figure 1*), which may be regarded as in most respects a typical individual. This plant (*plate 3*) was about 12 feet high, in good condition, and the observations upon it were begun earlier and continued longer than on any other, thus covering more varied conditions than in any other case. The furrows marked were all on the north side, the points selected for measurement being about halfway from the ground to the top of the plant; and consequently the curves constructed from these measurements show a much greater similarity than those for which the measurements were made at different heights and on different sides.

The observations were begun December 10. During the cold, dry weather which followed, the edges of the furrows slowly approached, one of them losing $\frac{10}{64}$ of an inch in width. On February 6 there was a rain of 0.54 of an inch,* and this was followed by warmer weather. After this rain, the furrows expanded rapidly for nearly a month. This period was probably prolonged somewhat as a result of some water being poured out near the plant in the latter part of February. About March 2 the furrows began to grow narrower, and this continued during the warm, dry weather of March and April. On May 2 and 3 there was a rain of about one inch and slight expansion of two furrows followed. It is not known whether this expansion continued, as the observations were now brought to a close.

Inspection of the curves shows at a glance that expansion and contraction of the stem, indicated by varying distances between adjacent ribs, is correlated with water-supply; a conclusion abundantly confirmed by observations upon other individuals, especially numbers 2 and 9, which were furnished with water from artificial sources.

Number 2 was situated about eleven feet from the end of the pipe that carried off the waste water from the laboratory, and the slope of the ground was such that the water flowed close around its base. On March 12 this was changed, a trough carrying the water past the plant and emptying it on the slope below, though some water still probably reached the roots of the plant through leakage of the trough.

* The statements as to amount of rain are all based on the records kept at the University of Arizona, some three miles from the Desert Laboratory, and 200 feet below it.

The first observations on this plant were made some three months after the opening of the laboratory, and judging from its full appearance and from other experiments, it is probable that the first effect of the water had been to cause an expansion of the stem. By the time observations were begun this had entirely ceased, but, as will be seen, it is evident that the presence of water in the soil was still exerting an influence. From January 9 to February 6, while the furrows of number 1 contracted $\frac{6}{64}$, $\frac{5}{64}$ and $\frac{4}{64}$ of an inch, two furrows of number 2 contracted only $\frac{1}{64}$ and a third $\frac{4}{64}$ of an inch (*figure 2*). The difference in the effect of the rain of February 6 was even more marked. While the furrows of number 1

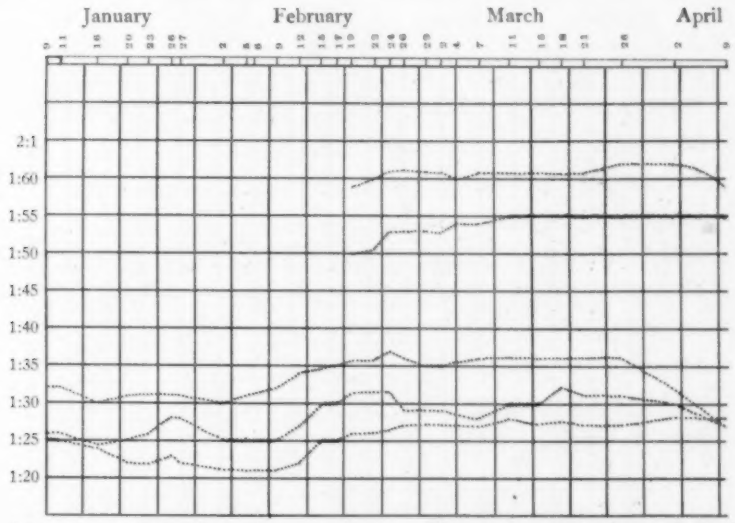

FIGURE 2. Curves for suaharo number 2. The measurements from which the three lower curves were derived were made on comparatively young branches, those for the two upper on lower and older parts of the stem. Rain, February 6 (0.54 in.).

showed an increase of $\frac{17}{64}$ to $\frac{20}{64}$ of an inch, those of number 2 only increased $\frac{6}{64}$ to $\frac{7}{64}$ of an inch, indicating that previous to the rain the cells of number 2 were much nearer their limit of expansion than those of number 1. It is evident then that the plant was able to avail itself to a considerable extent of the waste water of the laboratory, notwithstanding the large quantity of alkaline salts and other chemicals carried by it; and this is farther shown by its behavior after the period of expansion had ceased. Up to March 26, when the other cacti had been contracting for over

three weeks, number 2 remained practically stationary. After this, two of three furrows that were marked shrank; but it was now receiving very little water.

The correlation of the expansion and contraction of the stem with its water-supply is demonstrated still more clearly by the measurements of another individual designated as number 9. On February 15, when the cacti under observation were all in process of expansion, this plant was selected and watered in order to ascertain whether by this means the period of expansion could be prolonged. Until March 4 it was given 8 to 12 gallons of water three times a week; after that, it was watered once a week until

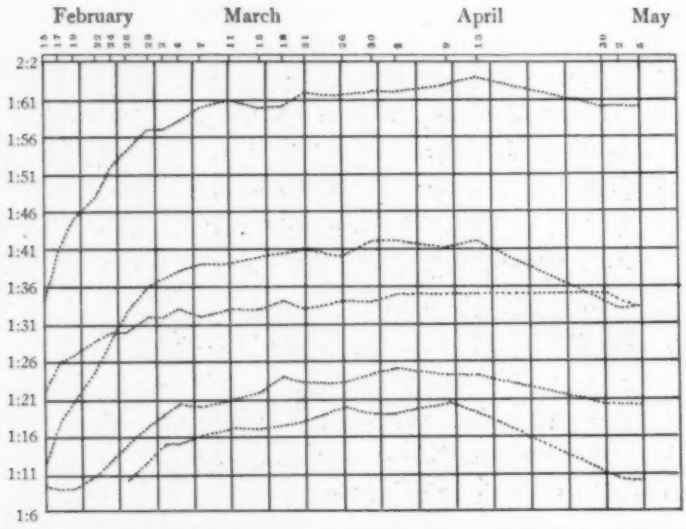

FIGURE 3. Representative curves derived from measurements of suaharo number 9. The lowest curve represents the variations in the thickness of a rib.

April 13. The water used was the ordinary tap-water charged with alkaline salts.

The behavior of the plant is shown by the curves in *figure 3*. It expanded very rapidly until about March 11, from one to three weeks after the other cacti had begun to contract. From then until between April 9 and 13 the furrows remained at about the same width while those of the others, except number 2, were contracting, some of them quite rapidly.

During this time, however, one cactus, number 4, accidentally

received a thorough wetting by overflow and subsequent leakage from the water tank. It immediately stopped contracting, and in the next few days all the furrows marked expanded from one sixty-fourth to ten sixty-fourths of an inch (*figures 8* and *9*, *curve 4*.) After the soil had dried the furrows again contracted.

Nothing could show more clearly the relation between water-supply and the expansion and contraction of the trunk of the giant cactus than a comparison of the behavior of these artificially watered plants and that of number 1. Some idea of the limit of expansion can be gained from number 9, which after expanding for about five weeks, remained nearly stationary for a month, though the plant was well watered once a week. This would also indi-

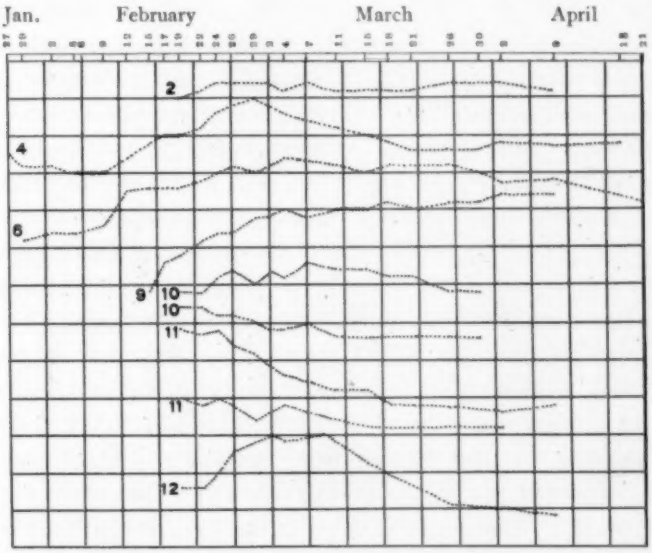

FIGURE 4. Curves derived from measurements near the bases of different plants. In this and the last two figures, in order to avoid confusion, the width of the furrows was ignored in placing the curves on the metric paper; and the figures refer to the number of the plant from which the curve was derived. Rain, February 6 (0.54 in.).

cate that the expansion which took place was the result of the absorption of water by the water-storing cells of the plant, and is not to be referred to growth.

The other suaharos that were measured—designated 6, 7, 10, 11, 12—agree substantially with what has already been stated regarding number 1. Two bisnagas—numbered 5 and 8—showed the same phenomena as the suaharos, but on a smaller scale.

During the observations, it became evident that while the plant as a whole responded in the way described to variations in its water-supply, different parts of the stem were affected in different degrees, and to such an extent that one furrow might even be contracting while another on the same plant was expanding. These facts are most evident from the records of plants that were not watered.

The lowest points at which measurements were made always showed a slow rate of change, and for a few inches below the apex the width of the furrows was stationary. Although observations were not sufficient to demonstrate any law as to comparative rate of change in different parts of the stem, a comparison of the curves in *figure 4* with those of any other set given will show that the variation near the base is less than higher up on the trunk.

This difference in the rate of change at various heights of the stem is no doubt mainly due to the different proportion of mechanical and water-storing tissue as shown in *figures 5, 6* and *7* representing sections taken at 8 feet, 5 feet, and 15 inches from the base of a plant 9 feet high, but the different consistency of the cell-contents in the upper and lower parts of the stem may also be a factor.

The fact that no two furrows on the same stem vary exactly alike, even when measured at the same height, may also be understood by reference to the same figures. The contour of the sections shows that, beginning at the top, where the furrows are nearly equal all around the stem, their width and depth on opposite sides differ more as we pass to the lower portions. The deeper and narrower furrows are on the south; and the wider, shallower ones on the north side of the stem; and as we pass down to the suberized tissue near the base of the larger individuals the furrows all become obliterated and the ribs are finally marked only by rows of spines.

A comparison of the measurements from the north and south sides of the same plants (*figures 8* and *9*) shows that contraction is greater on the south than on the north side, and that while the southern furrows may begin to expand earlier, the northern ones expand longer. This difference in action of the two sides corresponds with the configuration of the mature stem, and suggests an interesting inquiry regarding the combined influence of temperature

and light in the production of the form in question. To ascertain this and to find to what extent temperature as a secondary factor is active in the expansion and contraction of the stem would require observations extending over several seasons.

It will be instructive, however, to compare the curves already discussed with the temperature record for a corresponding period. From January 8 to 14 the mean temperature ranged from 42° to 56° F., and the effect of a rain of 0.2 of an inch was scarcely perceptible. From February 6 to 24 the mean temperature ranged from 47° to 68° F. and after a rain of half an inch the stems expanded steadily for three weeks. Later than this the mean temperature continued to increase during the period of observation, but, as already seen, the stems steadily contracted. It is noticeable, however, in comparing *figures 8* and *9*, that the furrows on the south side responded to the rain earlier than those on the north.

FIGURE 5. Section about 8 feet from the base, through the greatest diameter of the stem.

FIGURE 6. Section five feet from the base.

FIGURE 7. Section 15 inches from the base. The thin-walled, water-holding tissue becomes discolored almost immediately on contact with the air.

This very incomplete evidence indicates, as far as it goes, that temperature is an altogether subordinate factor, the effect of which, however, may increase or diminish that of water-supply.

Recurring again to the relation of the mechanical system to the processes of expansion and contraction, it would be difficult to imagine a more perfect arrangement for prompt and safe accommodation to variation in the large quantities of water held by these great columnar reservoirs. The strong central cylinder of fibro-vascular bundles necessarily retains the relative position of its elements through all such variations; and the peripheral band of mechanical tissue is so disposed as to promptly adjust itself, by the simple change of position that has been described, to changes

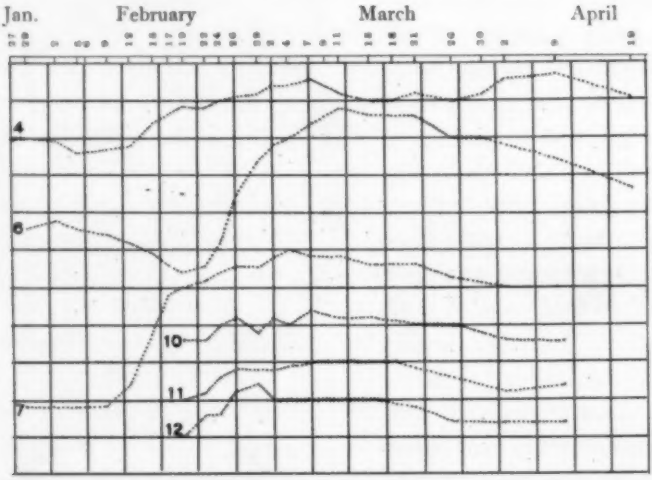

FIGURE 8. Six curves from as many different plants, each representing the variations of the furrow which faced nearest north. Rain, February 6 (0.54 in.).

in the bulk of the tissue which it surrounds. The circumference of the stem can therefore be increased or diminished without interfering in the slightest degree, as far as the present observations indicate, with the strength or efficient distribution of either the central or peripheral mechanical elements. That the change in girth may be considerable in a relatively short period is shown by the fact that some furrows of number 9, which was watered about two months, actually increased 35 per cent. of their original width, and that one furrow on a plant not watered expanded

one-half an inch in ten days after the rain of February 6 (*figure 9, curve 7*).

To summarize briefly, the foregoing observations lead to the following results:

1. Changes in the circumference of the stem of the suaharo are accomplished by a bellows-like action of the ribs, which draw closer together as the circumference decreases, and move farther apart as it increases.

2. These movements are directly correlated with increase and decrease in the water supplied to the plant, and with corresponding changes in the quantity of water held by its storage tissue.

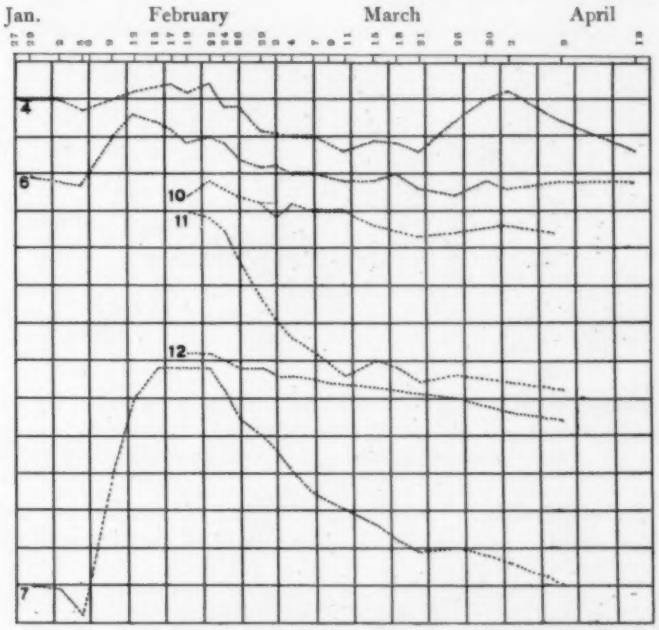

FIGURE 9. Six curves from the furrows facing nearest south on the same plants. The curves marked 4 in this figure and the preceding show the variation caused by an overflow of the water tank on March 18. Rain, February 6 (0.54 in.).

3. Variations in the circumference of the stem, due to changes of water-content, are not the same at all heights, but are least pronounced at the base and top.

4. In their expansion and contraction, the furrows on the north and south sides vary at different rates, which correspond with a difference in the configuration of the two sides.

5. Changes in the circumference of the stem effected by the mechanism described, while permitting free expansion and contraction of the water-storing tissue, leave the efficiency of the mechanical system unimpaired through all the vicissitudes to which the plant is subjected, and which it resists with a remarkable degree of success.

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Description of plates 3 and 4

PLATE 3. Suaharo number 1. Plant about 12 feet high, marked for observation about half way between base and apex.

PLATE 4. Suaharo number 4. A double-stemmed plant about six feet high, showing the very frequent enlargement of the stem near the top.

A new species of Lembosia

WILLIAM TITUS HORNE

Lembosia Rolfsii sp. nov.

Spots 1 to 2 cm. long extending partly or entirely around the stem, or several confluent. Young spots and margins only slightly discolored, pale yellowish-brown, becoming darker and

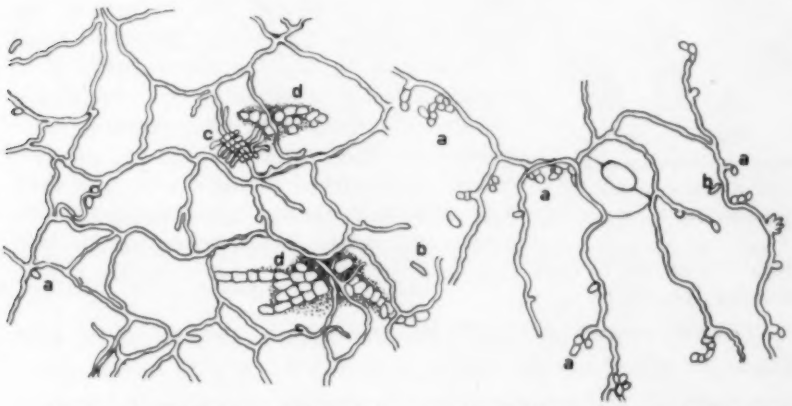


FIGURE 1. Two pieces of the mycelium on the cuticle near the margin of a spot, × 200. *a*, hyphopodia; *b*, detached conidia-like bodies; *c*, probably a young perithecium; *d*, structures of unknown significance lying below the cuticle.

specked with dark brown, or spot black. Mycelium of dark brown thick-walled hyphae without septae, freely branching and

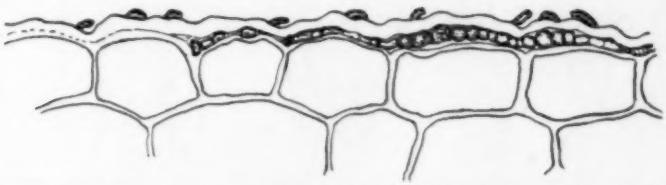


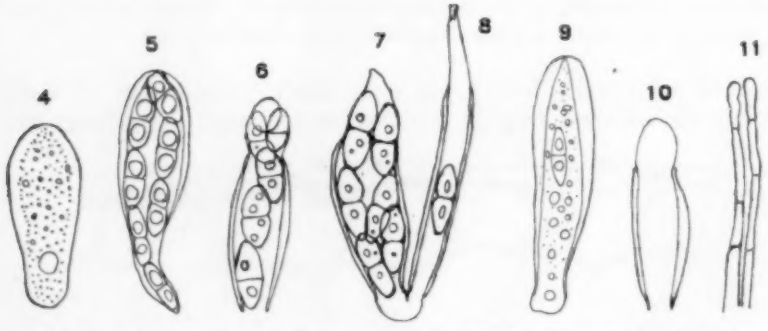
FIGURE 2. Transverse section 8 μ thick, mounted in balsam without stain, showing the position of the mycelium in hollows of the wavy cuticle and the position of the vesiculose mycelium-like growth between the cuticle and epidermal cells, × 300.

anastomosing, with numerous short haustoria-like branches (hyphopodia), forming a loose or dense network on the surface. Peri-

thecia irregularly scattered in the spots, straight or variously-curved, or forked, about 160 μ broad by 350 μ to 1 mm. long or more, continuous below with the mycelium, usually a little broader than high, black. Asci broadly clavate to elongated ovate, narrowed and often curved at base, at maturity thickly coated, 20–40 by 8–15 μ, the apex becoming produced into a sac-like extension 10 to 15 μ long which is collapsed and brown about the ruptured apex after the escape of the spores. Paraphyses abundant, somewhat irregular, the tips a little broader and clavate, separating with difficulty, 2–3 μ broad, not exceeding the expanded tips of the asci. Sporidia most commonly 6 in an ascus (probably 8 in uninjured asci), biseriate or irregularly crowded, 2-celled, somewhat pointed, constricted at the middle, slightly unsymmetrical and curved, hyaline with one very large oil drop in each cell, becoming smoky-brown and nearly black with one or two small oil-drops in each cell, and the darker spores mostly a little smaller, 10–16 by 4–5 μ.

FIGURE 3. Spores, × 800; the three upper hyaline or nearly so, the five lower brown.

On green stems of *Vanilla planifolia* Andr., the cells of the host below the mycelium becoming gradually filled with brown granular material, and groups of brown vesicles appearing irregularly



FIGURES 4 to 10. Asci, × 800. FIGURE 11. Paraphyses, × 800.

between the cuticle and epidermal cells and finally extending down into the intercellular spaces for a short distance. The significance of these structures was not made out. The superficial mycelium was not seen to penetrate below the cuticle in a large number of

microtome sections examined. Browning of the tissue is usually slight and was not seen distinctly for a depth of more than 1 mm.

The material studied was received from P. H. Rolfs, of the U. S. Subtropical Laboratory at Miami, Fla., in February, 1904.

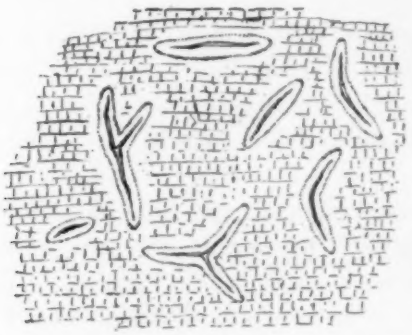


FIGURE 12. Part of spot with perithecia (partly diagrammatic), × about 10.

All attempts to make cultures from this material and from other lots kindly sent by Professor Rolfs failed, indicating that the species is probably a strict parasite.

On the names of three Jamaican species of Polypodium*

William Ralph Maxon

The first portion of the following notes is in advance of a more extended illustrated paper, the publication of which is unavoidably delayed, dealing with the species commonly associated with *Xiphopteris serrulata* (Sw.) Kaulf. under either *Polypodium* or *Xiphopteris*.

In 1804 † Schkuhr figured under the name *Grammitis myosuroides* a plant from Jamaica said to represent the Jamaican *Polypodium myosuroides* of Swartz (1788). Swartz himself in both the *Synopsis Filicum* and *Flora Indiae occidentalis* had so amended the original *Prodromus* (1788) description as to include the characters offered by Schkuhr's plant as represented in the plate; in fact, Schkuhr's plant was cited in the *Synopsis Filicum*. It is probable that the material possessed by both authors was very scant, and it is hardly to be wondered that two distinct species of this closely related group should, as we believe, have been thus confused. The strange feature is that with the more ample material since available for study, Schkuhr's plate should have been so universally misidentified and that the confusion of the several other species should have been so great.

For example: Hooker in 1861 described a *Xiphopteris Jamesoni* from Ecuador which is in reality identical with the true Jamaican *myosuroides* of Swartz (1788). The next year he incorrectly listed *myosuroides* Sw. as a synonym of *serrulatum* and cited Schkuhr's plate erroneously under *Polypodium setosum* (Kaulf.) Mett., an absolutely distinct species.

Jenman is the only writer who has clearly distinguished the several Jamaican species. He erred, however, in his use of specific

* Published by permission of the Secretary of the Smithsonian Institution.

† [Mr. Maxon wrote *1809*, the title-page date, supposing that the plate was *unpublished* when cited by Swartz in 1806. Schkuhr's work, however, was issued in parts; and the first part, containing the page (9) and plate (7) cited, appeared in 1804. A copy of this part, with its original cover, is in the editor's library. — J. H. B., Ed.]

names. As a matter of fact, Schkuhr's plate represents a plant specifically distinct from the *myosuroides* of Swartz' *Prodromus;* but Jenman, regarding the plate as truly illustrative of the Swartzian species — apparenty on the strength of its citation by Swartz — faithfully describes the Jamaican plants agreeing with the plate under the name *myosuroides.* The true *myosuroides* he describes under the Hookerian name *Jamesoni.*

We propose to restore the name *myosuroides* to the plants characterized by Swartz in the *Prodromus.* Schkuhr's plant has to this day never received a valid name.

The facts in the case, which are self-evident, were brought to our attention by the manifest inappropriateness of Jenman's application of the peculiarly descriptive term *myosuroides* — "mouse-tail-like," with obvious allusion to the "mouse-tail" apex or *cauda* — to plants not possessed of any such characteristic prolongation, *i. e.*, the plant figured by Schkuhr.

The synonymy will stand as follows:

POLYPODIUM MYOSUROIDES Sw. Prodr. 131. 1788.

Grammitis myosuroides Sw. Schrad. Jour. Bot. **1800**[2]: 18. 1801.

Polypodium myosuroides Sw. Fl. Ind. Occ. **3**: 1644. 1806, in greater part.

Grammitis myosuroides Sw. Syn. Fil. 22. 1806, in part, excluding reference to Schkuhr's plate.

Xiphopteris myosuroides Kaulf. Enum. Fil. 85, 300. 1824.

Xiphopteris Jamesoni Hook. Second Cent. Ferns *pl. 14.* 1861.

Polypodium serrulatum β strictissimum Hook. Sp. Fil. **4**: 175. 1862.

Polypodium Jamesoni Jenman, Bull. Bot. Dept. Jamaica II. **4**: 112. 1897.

JAMAICA; BRITISH GUIANA; VENEZUELA; ECUADOR.

Jenman's description of this species under the name *Polypodium Jamesoni* is in all respects a true one, based upon the common and typical Jamaican plants.

Polypodium delitescens nom. nov.

Grammitis myosuroides Schkuhr, Krypt. Gewächse, **1**: 9. *pl.* 7. 1804; not Sw. 1801.

Polypodium myosuroides Jenman, Bull. Bot. Dept. Jamaica II. **4**: 112. 1897; not Sw. 1788.

Apparently confined to Jamaica.

The species is well characterized by Jenman under the name *Polypodium myosuroides*. It is to be distinguished from the true *myosuroides*: (1) commonly by its pinnatifid condition throughout, though less deeply lobed in the upper (fertile) portion than below; (2) by its distinct sori, these never entirely confluent with age, a character consequent upon its pinnatifid condition; (3) by its *approximate* nearly deltoid lobes, these never remote or subspatulate as in *myosuroides;* and by numerous less obvious characters as determined from a large series of specimens obtained in Jamaica by Mr. Jenman, Professor Underwood and the writer.

Schkuhr's original plant, if existent, will stand as the type; otherwise the type will be sheet *no. 427770*, in the U. S. National Herbarium, collected at the Summit of Blue Mountain Peak, altitude about 2220 meters, *Maxon 1513*, April 20, 21, 1903. *Underwood 2579*, in the herbarium of the New York Botanical Garden, has identical data.

The following note, which is without reference to the foregoing, has to do merely with the untenable name *saxicolum* given by Baker to a Jamaican high-mountain ally of *Polypodium moniliforme*. The plant occurs entangled with great mats of liverworts and mosses which closely envelope not only rocks but tree-trunks in the higher forested slopes of the Blue Mountains. Its characteristic growth has suggested the following name:

Polypodium induens nom. nov.

Polypodium saxicolum Baker, Jour. Bot. Brit. & For. **15**: 264. 1877. Not *Polypodium saxicola* Sw. Vet. Akad. Handl. Stock. **1817**: 59. 1817.

The specimens in the U. S. National Herbarium are:

JAMAICA. — A sheet without definite locality (ex herb. Botanical Dept. Jamaica). Near Morce's Gap, altitude 1500 meters; *Maxon 1214* and *2770*. Highest slopes of John Crow Peak, altitude 1650–1800 meters; *Maxon 1324* and *1332*.

U. S. NATIONAL MUSEUM.

New species of fungi

CHARLES HORTON PECK

Lepiota maculans

Pileus thin, convex, subumbonate, dry, minutely and densely squamulose, reddish-yellow, the center darker; lamellae broad, subdistant, free, white, gradually changing to red or pink; stem equal, tough, floccose or fibrillose, hollow, whitish or yellowish, the annulus slight, evanescent; spores elliptic, uninucleate, pointed at the ends, variable in length, 8–12 μ long, 5–6 μ broad.

Pileus 1.5–2 cm. broad; stem about 5 cm. long, 2–3 mm. thick.

St. Louis, Mo. September. N. M. Glatfelter.

This is a small but pretty species, easily known by the flesh of both pileus and stem changing to a reddish color where wounded and by the lamellae assuming a reddish or pink color with age or in drying.

Mycena denticulata

Pileus thin, subcampanulate or convex, obtuse, glabrous, gray tinged with brown, the cuticle separable; lamellae rather broad, subdistant, ventricose, decurrent with a tooth, pale-brown, purplish on the edge, usually denticulate; stem slender, equal, straight, hollow, glabrous, whitish or yellow; spores elliptic, 7–8 μ long, 4–5 μ broad.

Pileus 12–20 mm. broad; stem 5–7 cm. long, 1–2 mm. thick.

St. Louis, Mo. August. N. M. Glatfelter.

Pleurotus umbonatus

Pileus fleshy, convex, umbonate, fibrillose, subsquamulose, brown or blackish-brown, flesh white, the cuticle sometimes rimose; lamellae broad, subdistant, adnate or slightly decurrent, brownish when dry; stem eccentric, equal or tapering downward, stuffed or hollow, colored like or a little paler than the pileus; spores white, subglobose or broadly elliptic, 5–6 μ long, 4–5 μ broad.

Pileus 2–7 cm. broad; stem 2–4 cm. long, 0.5–1 cm. thick.

Ground. Kittanning, Pa. October. D. R. Sumstine.

Lactarius Sumstinei

Pileus rather thin, dry, glabrous, even or slightly and radiately rugulose, centrally depressed, the margin spreading or decurved, grayish or pale smoky-brown, flesh whitish, milk whitish, unchangeable, taste acrid; lamellae thin, distant, unequal, decurrent, creamy-yellow; stem nearly equal, glabrous, stuffed or hollow, colored like the pileus; spores globose, echinulate, yellowish, 7.5–10 μ broad.

Pileus 2.5–7.5 cm. broad; stem 2.5–5 cm. long, 6–12 mm. thick.

Grassy places in open woods. Kittanning, Pa. August. D. R. Sumstine. Related to such species as *Lactarius fuliginosus*, *L. Gerardii* and *L. lignyotus*. It may be separated from the first by its unchangeable milk and its more distant lamellae and from the others by its acrid taste.

Marasmius Sutliffae

Pileus thin, tough, subcampanulate or convex, glabrous, shining when moist, reddish-brown, often darker in the center, taste bitter; lamellae broad, moderately close, subventricose, adnexed, white, often with a slight pinkish tint, interspaces venose; stem slender, cartilaginous, hollow, glabrous or slightly pruinose, pallid, with a whitish tomentum at the base; spores white, elliptic, 8–10 μ long, 5–6 μ broad, often containing a shining nucleus.

Pileus 1–2 cm. broad; stem 2.5–4 cm. long, 2–3 mm. thick.

On lawns in shaded places. Sacramento, California. October and November. Miss M. L. Sutliff.

I take pleasure in dedicating this interesting species to its discoverer. She writes that in her trial of its edible qualities she found that cooking seemed to intensify its bitter flavor and make it rival that of quinine.

Panus meruliiceps

Pileus tough, firm, compact, convex, glabrous, reticulated with elevated anastomosing ridges, involute on the margin, pale brick-red becoming tinged with yellow in the center, flesh white, 1–1.5 cm. thick; lamellae narrow, close, adnate or slightly decurrent with a tooth, slightly connected at the base, whitish; stem eccentric, curved, solid, fibrous, glabrous, grooved, white; spores subglobose or broadly elliptic, pinkish-tinged, 7 μ long, 6 μ broad.

Pileus 2.5–4 cm. broad; stem 2.5–4 cm. long, 8–12 mm. thick.

Trunks of elm trees. St. Louis, Mo. N. M. Glatfelter.

This is a very rare and peculiar species of which only five specimens have yet been found. One was found in April and one in May, 1898, one in May, 1902, and two in July, 1903. The specimen sent for identification was still flexible when received in March, 1904, showing that the mushroom dries with extreme slowness and does not readily become hard and brittle.

• Flammula multifolia

Pileus convex, subumbonate, glabrous or obscurely fibrillose, tawny-yellow, sometimes paler on the margin and darker in the center, the margin incurved, flesh faintly tinged with yellow; lamellae narrow, numerous, crowded, rounded behind, adnexed, colored like or a little paler than the pileus, the edges crenulate with yellow or reddish-yellow glandular drops; stem equal or slightly thickened at the base, solid, floccose, fibrillose or subglabrous, yellow, sometimes eccentric; spores subglobose, 4–5 μ broad.

Pileus 5–8 cm. broad; stem 2.5–3.5 cm. long, 2–5 mm. thick.

Decaying wood in ravines. St. Louis, Mo. N. M. Glatfelter.

• Cortinarius Braendlei

Pileus fleshy, firm, convex with incurved margin, silky, brownish-lilac, often varied by yellowish-brown stains, the young margin covered by the grayish-white silky veil, flesh lilac, specially in the young plant, odor like that of radishes; lamellae narrow, close, slightly rounded behind, adnate, eroded on the edge, grayish tinged with lilac; stem stout, solid, silky-fibrillose, bulbous, white or whitish; spores oblong-elliptic, obscurely granular, 12–15 μ long, 7–8 μ broad.

Pileus 7–12 cm. broad; stem 5–7 cm. long, 10–15 mm. thick.

Among fallen leaves in woods. Washington, D. C. October. F. J. Braendle.

Sometimes the pileus loses all its lilac color and becomes wholly yellowish-brown. The bulb of the stem is often pointed below. The species belongs to the section *Inoloma*.

• Cortinarius Morrisii

Pileus fleshy except on the thin and at length reflexed margin, convex, irregular, hygrophanous, ochraceous or tawny-ochraceous, flesh thin, colored like the pileus, odor weak, like that of radishes; lamellae broad, subdistant, eroded or uneven on the edge, rounded behind, adnexed, pale-yellow when young, becoming darker with

age; stem nearly equal, fibrillose, solid, whitish or pale-yellow and silky at the top, colored like the pileus below and fibrillose, irregularly striate and subreticulate, the double veil whitish or yellowish-white and sometimes forming an imperfect annulus; spores tawny-ochraceous, subglobose or broadly elliptic, uninucleate, 8–10 μ long, 6–7 μ broad.

Pileus 3–10 cm. broad; stem 7–10 cm. long, 1–2 cm. thick.

Moist shaded places under hemlock trees. Ellis, Mass. August to October. G. E. Morris. The species belongs to the section *Telamonia*.

Stropharia Schraderi

Pileus fleshy, firm, convex becoming nearly plane, dry, fibrillose, squamose or rimose-squamose in the center, pallid when young, becoming tinged with ochraceous-buff when mature, flesh white, taste like that of radishes; lamellae thin, close, adnate, whitish becoming brown; stem short, solid, subequal, white and sprinkled with mealy particles above the annulus, colored like the pileus and squamose below, annulus small, lacerated, white and sometimes evanescent; spores elliptic, 7–8 μ long, 4–5 μ broad.

Pileus 5–8 cm. broad; stems 2–3 cm. long, 8–12 mm. thick.

Sandy grassy soil about stumps. Washington, D. C. October. F. F. Schrader.

Psathyra multipedata

Pileus submembranaceous, conic or hemispheric, glabrous, hygrophanous, light-bay or tawny when moist, cinereous when the moisture has escaped, the center retaining its moisture longer than the margin; lamellae thin, close, adnate, pallid or gray becoming brown, whitish on the edge; stem slender, equal, hollow, brittle, furfuraceous, becoming smooth or sometimes remaining fibrillose near the base, pure white; spores brown, elliptic, 6–8 μ long, 4–5 μ broad.

Pileus 12–16 mm. broad; stem 5–10 cm. long, 2 mm. thick.

Densely cespitose, forming tufts of many individuals. Grassy ground. St. Louis, Mo. September and October. N. M. Glatfelter.

This is related to *P. bifrons* and *P. semivestita*. From the former it may be separated by the absence of red or pink tints from the pileus and from the latter by its smaller size and smaller spores.

Geopyxis nebulosoides

Receptacle cupular, stipitate, 2–6 mm. broad, pale-gray, externally pruinose or minutely mealy, the margin usually incurved;

hymenium pale-gray; stem equal to or slightly exceeding the diameter of the receptacle, even or sulcate, pruinose; asci cylindric, 200 μ long, 12 μ broad; spores oblong-fusiform, blunt or pointed at the ends, even, 25–40 μ long, 7–8 μ broad, containing 1–6 shining oil-globules; paraphyses filiform, often a little longer than the asci.

Decorticated wood. Canada. J. Macoun.

The species is closely related to *G. nebulosa* Cooke, from which it may be distinguished by its longer somewhat sulcate stem, its pruinose exterior and its smooth nucleated spores.

The Polyporaceae of North America — X. Agaricus, Lenzites, Cerrena, and Favolus

William Alphonso Murrill

Plants with variable daedaleoid or lamelloid hymenium and light-colored context and spores form the subject of the present article. These plants, like those of the genus *Sesia* discussed in article IX, recognize none of the ordinary specific or even generic limitations of the group and must be treated in a class by themselves. If they were amenable to ordinary methods of cultivation, they would surpass *Oenothera* in supplying most excellent examples of mutation.

Through the genus *Favolus*, taken up at the close of this paper, we return to the normal poroid forms of the family.

AGARICUS (Dill.) L. Sp. Pl. 1176. 1753

Striglia Adans. Fam. Pl. **2**: 10. 1763.
Daedalea Pers. Syn. Fung. 499. 1801.
Daedaleopsis Schroet. Krypt. Fl. Schles. **3**: 492. 1888.

The type of the genus *Agaricus* is *Agaricus quercinus* L. This is the only species common to Linnaeus and Dillenius, the author of the genus. Primarily, the name *Agaricus* was applied to dimidiate woody forms and the application of the present code* restores it to one division of this group. It is unfortunate that the association of fleshy and woody forms by Linnaeus under the name *Agaricus* has entirely diverted it from its earlier use and made necessary a number of changes in its restoration. Such changes could be avoided in only one way, *i. e.*, by applying canon 15 (f) of the code, which allows a well-known economic species to be selected as the type in order to avoid change in the current application of a Linnaean generic name. *Agaricus campestris* is such a species and *might* be adopted as the type of the genus *Agaricus*. I hesitate, however, to make use of a provision designed especially for *Poa pratensis*. I fear also that this provision, being the only one

* Bull. Torrey Club, **31**: 249–261. 1904.

of its kind in the code, is in danger of being overworked. Moreover, I have good reason to know that a mere makeshift of this kind will never be accepted by working mycologists as permanent. *Agaricus*, then, properly figures as a genus of the *Polyporaceae*.

The genus *Striglia* was founded by Adanson upon Batarra's *plate 38*, which represents several common species of *Agaricus*, the first being *A. quercinus* L.

Daedalea of Persoon was founded on *D. quercina* (L.) and four other species, one of them being *D. confragosa*. Batarra is quoted at some length and *plate 38* cited by Persoon, but no mention is made of *Striglia*, based on the same plate.

Daedaleopsis, founded upon the single species *Daedalea confragosa* (Bolt.), completes the list of synonyms.

Species belonging to the genus *Agaricus* have white or wood-colored context, hyaline spores and poroid, daedaleoid or lamelloid tubes. One rare species, *A. juniperinus*, occurs on coniferous wood; all the others are found abundantly on decaying wood of various deciduous trees. One species, *A. deplanatus*, is tropical; the rest occur in the United States and Canada, and two of these are found also in Europe. Most of the species, in spite of the remarkable variability of some of them, are easily distinguished; *A. Aesculi* and *A. deplauatus*, however, approach very near each other in some of their forms.

Synopsis of the North American species

1. Tubes one to several millimeters in transverse diameter; surface usually brown or discolored; plants found in temperate regions. 2.
   Tubes less than one-half millimeter in transverse diameter; surface white or yellowish; plants found in the southern states or the tropics. 3.

2. Pileus thick, triangular, margin obtuse; tubes large, daedaleoid, dissepiments obtuse; context wood-colored; plants abundant on oak. 1. *A. quercinus*.
   Pileus thick, triangular, margin obtuse; tubes large, daedaleoid, dissepiments obtuse; context white; plants rare on red cedar. 2. *A. juniperinus*.
   Pileus thin, applanate, multizonate, margin very acute; hymenium poroid, daedaleoid or lamelloid, dissepiments acute. 3. *A. confragosus*.

3. Pileus reniform, rigid, usually azonate; plants found in the southern states. 4. *A. Aesculi*.
   Pileus thin, flexible, variously shaped, usually multizonate; plants confined to the tropics. 5. *A. deplanatus*.

1. AGARICUS QUERCINUS L.

Agaricus quercinus L. Sp. Pl. 1176. 1753.—Sow. Engl. Fung. *pl. 181.*
Agaricus labyrinthiformis Bull. Herb. Fr. *pl. 352.* 1787.
Daedalea quercina Pers. Syn. 500. 1801.
Polyporus latissimus Fr. Obs. **1**: 128. 1815.
Daedalea quercina var. *nigricans* Fr. Syst. **1**: 333. 1821.

This very common species has been known from ancient times on account of its size and abundance and because it grows on stumps and timbers in conspicuous places. The abundant use of oak, its favorite host, brings it to the attention of many. Bauhin and other prelinnaean botanists seem to have been impressed with the striking appearance of its hymenium, expressed by Linnaeus in his "Agaricus acaulis, lamellis labyrinthiformibus" and by Bulliard in his choice of a specific name. The figure on Batarra's plate 38 is a rather old blackened form of this species, distinguished by him as a variety and cited by Fries as var. *nigricans*. *Polyporus latissimus* was described by Fries from resupinate forms frequent on structural oak timbers before he was well acquainted with the variations of the species. As this species is so extremely common and well-known, it is not considered necessary to give a list of available collections. All the exsiccati contain specimens of it, and one can hardly fail to find it at any season of the year on some oak stump or decaying trunk.

2. **Agaricus juniperinus** sp. nov.

Sporophore corky, sessile, attached by a broad, often decurrent, base, composed of imbricate, terraced or laterally connate, ungulate pilei 2–5 × 2–7 × 1.5–3 cm.; surface irregular, anoderm, finely tomentose, yellowish-white, becoming cinereous with age; marginal edge fertile, concolorous, not rounded, but often forming an obtuse angle: context corky, white, concentrically banded, 0.5–1 cm. thick; furrows large, labyrinthiform, radially, rarely otherwise, elongated, 0.5–2 cm. long, 1–3 mm. wide, white or pallid, edges obtuse, often splitting into broad irpiciform plates: spores smooth, hyaline, ovoid, 3–4 × 5–6 *μ*.

The type plants of this species were collected by Bartholomew on a red cedar stump near Rockport, Kansas, November 8, 1894. It was again collected by Bartholomew on the same host but in a

different locality in 1896, and Demetrio found it in Cole County, Missouri, September, 1898, growing in a decayed spot on a living red cedar trunk.

The nearest American congener of this species is probably *A. quercinus*, from which it may be easily distinguished by its milk-white context. It is also known only on red cedar, while *A. quercinus* occurs on the wood of deciduous trees.

3. **Agaricus confragosus** (Bolt.)

Boletus confragosus Bolt. Halifax Fung. Suppl. **3**: 160. *pl. 160.* 1791.
Daedalea confragosa Pers. Syn. 501. 1801.
Daedalea rubescens Alb. & Schw. Consp. Fung. 238. *pl. 11. f. 2.* 1805.
Daedalea albida Schw. Syn. Car. 67. 1818. Fr. Not *D. albida.*
Daedalea zonata Schw. Syn. Car. 68. 1818.
Daedalea discolor Fr. Elench. Fung. 68. 1828.
Daedalea discolor Kl. Linnaea **8**: 481. 1833.
Daedalea corrugata Kl. Linnaea **8**: 481. 1833.
Trametes rubescens Fr. Epicr. 492. 1836.
Lenzites Klotzschii Berk. Ann. Mag. Nat. Hist. **7**: 452. 1841.
Lenzites Crataegi Berk. Lond. Jour. Bot. **6**: 323. 1847.
Lenzites unguliformis B. & C. Hook. Jour. Bot. **1**: 101. 1849.
Lenzites bicolor Fr. Nov. Symb. 43. 1851.
Lenzites Cookeii Berk. Grevillea **4**: 161. 1876.
Lenzites proxima Berk. Grevillea **4**: 162. 1876.

This remarkable species has a literary history in keeping with its wonderful variation in nature. Bolton appears to have the credit of noticing it first, and, fortunately, his description and figures are excellent. He speaks of it as growing on stumps and the dead roots of trees at Fixby-Hall, the type locality, and other places in Halifax. His description is here given:

"Boletus coriaceo lignosus sessilis dimidiatis, supra scabroso zonatus subfuscus, carne ferrugineo-pallide, tubis cinereis poris multiformis."

Persoon made use of Bolton's name, but does not seem to be clear as to the identity of the plant in question. Albertini and Schweinitz described it under the name of *D. rubescens*, at the

same time questioning whether it might not be the same as *D. angustata* (Sow.) Fr. Schweinitz again described the thin forms met with in Carolina under different names, which were much discussed by European mycologists.

Fries changes one of Schweinitz's specific names to *D. discolor* in his Elenchus, because it was preoccupied by one of his own. Type plants of this species grew on birch trunks. A little later, Klotsch finds a specimen in Hooker's herbarium collected by Dr. Richardson on a birch trunk in boreal North America, which he determines as *D. discolor* Fr., but Fries disclaims it and calls it *D. discolor* "Kl. *nec* Fr." Then Berkeley throws the species into *Lenzites* and names it after Klotsch. This is only the beginning of Berkeley's career in connection with *D. confragosa*, for we find him between this time and 1876 assigning four new names to different specimens of this species, *L. Crataegi* to plants collected in Ohio by Lea, *L. unguliformis* to specimens sent from North Carolina by Curtis, *L. Cookeii* to Peck's specimens collected on willow and birch in New York and *L. proxima* to New York plants collected by Sartwell. *L. Lyallii* Berk. from Vancouver also seems to be a form of this species, but the type plants are in such poor condition that it is impossible to determine this with certainty.

A form found in Mexico by Schiede and recently duplicated by Smith appears to have as much claim to distinction as any yet reported, if it were only possible to separate it from thin lenzitoid forms found in the Southeastern states. In describing this form in 1851, as *L. bicolor*, Fries says that he had received the same thing from Curtis in South Carolina under the name of *D. tricolor*. A full discussion of this and several other varieties, by Peck, may be found in the 30th Report of the N. Y. State Museum of Natural History; on page 73 the author summarizes the forms discussed which have received specific names as follows:

"*Daedalea confragosa* Pers. which is represented by forms of our plant having a scabrous somewhat zoned pileus of a reddish-brown color and a daedaleoid hymenium."

"*Trametes rubescens* A. & S. which is represented by forms that assume the ruddy color and have the trametoid hymenium."

"*Lenzites Crataegi* Berk. which is represented by forms having a shining pileus attached by the vertex and having a trameto-lenzitoid hymenium."

"*Lenzites Cookei* Berk. which is represented by forms with the pileus of a cervine hue and with a trameto-lenzitoid hymenium."

"*Lenzites proxima* Berk. with the thin flattened pileus completely overspread by the peculiar tomentum previously described."

Peck considers all these varieties of one protean species and suggests that the specific names under which they were described be retained as varietal names.

After the study of a quantity of material, including most of the original type collections, and numerous observations of various stages of this plant in the field, I am forced to confess that in spite of its wonderful variation in size as well as in general appearance, I find it impossible to make more than one species of it. When the ordinary form common in New York is compared with specimens from the Carolinas only 1 cm. in diameter and they in turn with large, thick poroid forms from Florida or very thin, expansive lenzitoid forms from Mexico, one at once concludes that he is dealing with different plants; but let a large array of specimens from different localities be examined and all the specific distinctions seem to disappear in well-graded intermediate forms which are with difficulty set aside. It is not strange that the foreign mycologists who had only isolated specimens to deal with should have erected so many species.

In examining European forms, some are easily recognizable as distinct from those seen in America, but, knowing this plant as we do at home, who shall attempt to separate any of them specifically!

This species is met with abundantly about New York growing on dead trunks or branches of sweet gum, willow, birch, oak, dogwood, alder, beech and other deciduous trees and shrubs. The tubes are usually daedaleoid, sometimes porous, when young, very pale flesh-colored, turning at once to yellowish-brown when bruised. The surface is light to dark yellowish-brown and the margin, which is lighter, shows fan-like radiations of growth. Zones may or may not be present. As the fruit becomes older, the tubes very often become lenzitoid and various changes take place in the appearance of the surface. The spores are hyaline, cylindrical, $9 \times 2\ \mu$.

The following collections will indicate the wide range of the species in North America: Rav. Fung. Car. Fasc. 2. nos. *15* and

416; Ell. & Ev. N. A. Fung. *1924, 1925, 1926, 1927, 1928*; Underw. & Cook, Illus. Fung. *18*; Shear, N. Y. Fung. *40*; Canada, *Macoun, Dearness*; Maine, *Blake, Miss White*; Connecticut, *Seymour, Earle, Miss White, Underwood*; New York, *Barbour, Peck, Mrs. Britton, Underwood, Earle, Murrill*; New Jersey, *Martindale, Earle, Anderson, Murrill*; Delaware, *Commons*; Pennsylvania, *Stevenson, Sumstine, Gentry*; Maryland, *Miss Banning, Shear, Ricker*; Virginia, *Murrill*; North Carolina, *Memminger*; Georgia, *Harper 2037a, 2042*; Alabama, *Earle, Baker*; Louisiana, *Langlois*; Florida, *Calkins*; Ohio, *Morgan*; Tennessee, *Murrill 594, 607*; Kansas, *Bartholomew*; Wisconsin, *Baker*; Texas, *Hodson*.

4. **Agaricus Aesculi** (Schw.)

Boletus Aesculi flavae Schw. Syn. Fung. Car. 70. 1818.
Polyporus Aesculi Fr. Elench. 99. 1818.
Trametes inzana Berk. Lond. Jour. Bot. **4**: 305. 1845. Not *T. incana* Lév.
Daedalea ambigua Berk. Lond. Jour. Bot. **4**: 305. 1845.
Trametes ambigua Fr. Nov. Symb. 96. 1851.
Trametes lactea Fr. Nov. Symb. 96. 1851.
Lenzites glaberrima B. & C. Grevillea **1**: 34. 1872.
Daedalea glaberrima B. & C. Grevillea **1**: 67. 1872.
Trametes Berkeleyi Cooke in Sacc. Syll. Fung. **9**: 194. 1891.

The first description recorded of this species is that made by Schweinitz in his Synopsis under the name of *Boletus Aesculi flavae*, which is as follows:

"B. minor subimbricatus, pileo dimidiato duriusculo fornicato glabriusculo pallido margine sterili, poris minutis sulphureis."

"In arboribus, imprimis *Aesculi flavae* Wilkes County, ad ripam Yadhin. Caespites duas tresve uncias longi. Parum imbricatus, fere simplex. Pileus suberosus, subtenuis, basi crassior, glaber, tactu subtomentosus. Pori demum nigrescunt."

This is not a good description of the plant. Several statements in it are misleading as well as incomplete. It is possible that Schweinitz confused this species with one ordinarily known as *P. hemileucus*, rather common in the Carolinas. This supposition would account for Fries' remark with reference to the specimen sent him by Schweinitz that it was "*rubiginosus*." How-

ever, the plant in the Schweinitz herbarium is undoubtedly *Daedalea ambigua* and not *P. hemileucus*, which settles the question of type.

Trametes incana Berk. was founded on specimens collected by Lea on dead trunks of trees in Ohio. These specimens were possessed of a very short lateral, disciform stem, a yellowish hymenium and roundish, or rarely linear and sinuous, pores. The name was changed to *Trametes Berkeleyi* in 1891 by Cooke because of *Polyporus* (*Trametes*) *incana* Lév. (Bonite, Crypt. 183. 1844–1846), described from the Philippines. Although *Trametes* seems to be used here as a subgenus, the author writes it as a genus lower down on the same page when he comes to refer to and describe the figures: "*Pl. 137. f. 2. Trametes incana* de grandeur naturelle," etc.

Daedalea ambigua was described by Berkeley in almost the same breath with the previous species and the specimens were collected in the same locality by Lea. Montagne considered the two species the same, but Berkeley, influenced to a considerable extent by Lea, finally decided to make them distinct because of the narrow, sinuous pores of the latter.

Trametes lactea was described from plants sent to Fries from Carolina by Curtis. These plants were evidently porous forms of this species and naturally fell under the genus *Trametes* so far as Fries could determine from the material.

Lenzites glaberrima was also described from Carolina material sent by Curtis. This time the tubes were lenzitoid and anastomosing and there was an orbicular disc for the base.

Daedalea glaberrima was meant by Berkeley for an entirely distinct species. The pores are described as "at length sinuous" and the stem as "lateral, one-half an inch long and wide." The type specimens were sent from South Carolina by Curtis.

In addition to the above, several other names have been used quite freely by collectors and systematists in connection with this species. *Trametes marchionica*, for example, described from the Marquesas Islands by Montagne (Voy. Pole Sud, 204. 1845), is often treated as a synonym of *D. ambigua*. *Trametes Mülleri* Berk. is applied to Cuban forms of *D. ambigua* at Kew and elsewhere, although the type locality of the species is the Victoria

River, Australia. There is ample excuse for this, however, in the fact that this species is described in a work on Cuban fungi and is undoubtedly considered by the author to exist in Cuba; nevertheless, since no definite statement to this effect nor the citation of a collector's number accompanies the description, the type locality as given and also as implied in the personal specific name must be considered the correct one for the species. There exists a very close relationship between the various forms of *D. ambigua* and species described from regions of the Orient, but a discussion of this relationship is beyond the scope of the present article.

As one may judge from the above discussion, *Agaricus Aesculi* is a variable species and liable to confuse the collector who relies too much upon regularity of pore-structure. If one considers the variability of the genus, however, he will have little trouble in distinguishing it by color, surface and size. It is found on stumps, trunks, and other forms of decaying wood of oak, sycamore, etc., in the Southern states. Specimens are at hand from Missouri, *Demetrio;* Kansas, *Bartholomew;* Ohio, *Morgan, Lloyd;* South Carolina, *Ravenel;* Florida, *Martin, Rau, Calkins, Lloyd;* Texas, *Hodson 320.*

5. **Agaricus deplanatus** (Fr.)

Daedalea elegans Spreng. Vet. Acad. Handl. 51. 1820. — Fr. Syst. **1**: 335. 1821; Elench. 69. 1828. Not *Agaricus elegans* Scop. Fl. Carn. ed. 2. **2**: 438. 1772.
Daedalea deplanata Fr. Linnaea **5**: 513. 1830.
Lenzites deplanata Fr. Epicr. 404. 1838.
Trametes elegans Fr. Epicr. 492. 1838.
Trametes centralis Fr. Nov. Symb. 95. 1851.

The name *Daedalea elegans* was first assigned to plants found on tree trunks in Guadeloupe. Sprengel's original description is as follows:

"D. coriaceo-lignosa sessilis, pileo supra albido glaberrimo, subtus alutaceo, lamellis anastomosantibus in poros marginales abeuntibus."

This was enlarged by Fries after the study of a considerable variety of forms. Ten years later Fries himself described another form of the same species collected by Beyrich in Brazil under the name of *Daedalea deplanata.* His *Trametes centralis,* also a syno-

nym, is based upon collections made in the West Indies, Costa Rica and Mexico, in which the sporophores are sessile at the center, with pores decurrent to the base.

Other species, either synonymous or closely related to those above described, but purposely kept separate at this time from North American forms are as follows:

Daedalea amanitoides Palis. de Beauv. Fl. Owar. **1**: 44. *pl. 25.* 1804. *Daedalea Palisoti* Fr. Syst. **1**: 335. 1821. *Lenzites Palisoti* Fr. Epicr. 404. 1838. Afzel. Fung. Guin. **1**: *pl. 11. f. 23. a, b.* The species was described from Oware, growing on trunks. I know of no reason for changing the specific name to *Palisoti.*

Daedalea repanda Pers. Freyc. Voy. 168. 1826. Mont. Cuba 382. *pl. 14. f. 4.* 1842. *Lenzites repanda* Fr. Epicr. 404. 1838. (Not *Agaricus repandus* Bull.) Described from the island of Rawak as "D. latissima albido-pallens, pileo glabro zonato margine repando, sinulis angustis densis, margine subdentatis." Montagne adopts the name for Cuban specimens and cites *D. polita, D. deplanata, D. laevis, D. applanata, D. Palisoti* and *D. indica* as synonyms. He appears to have given considerable attention to the various forms in Cuba with reference to growth and variation.

Daedalea polita Fr. Linnaea **5**: 514. 1830. *Lenzites polita* Fr. Epicr. 404. 1838. Described from specimens in the herbarium of Willdenow collected by Bory on Bourbon, or Reunion, Island. The type in Fries' herbarium has the exact contour of *A. Aesculi,* but is thinner. The surface is like that of *A. Aesculi,* but the pores are more like those of *A. deplanatus.*

Daedalea applanata Kl. Linnaea **8**: 481. 1833. *Lenzites applanta* Fr. Epicr. 404. 1838. Collected on trunks in the island of Mauritius by Telfair and described from the herbarium of Hooker. The author questions if it is not *D. deplanata* Fr. or *D. polita* Fr.

Polyporus (*Trametes*) *lactineus* Berk. Ann. Mag. Nat. Hist. **10**: Suppl. 373. 1843. Described from specimens collected by Koenig in Ceylon and named by him in herbarium "*Boletus lacteus.*" Berkeley does not distinguish it from forms found in the West Indies.

Lenzites platypoda Lév. Bonite, Crypt. 184. 1844–1846. This appears to be in no way specifically distinct from *Daedalea repanda*

Pers., but the author, who was at that time but little acquainted with oriental forms, thinks that the stipe and pores sufficiently distinguish it from Persoon's species.

This exceedingly variable and very attractive species is abundant on decaying wood in tropical America. In some localities the young sporophores, although tough, are used as food by the natives. It differs from *A. Aesculi* in being thin and flexible and usually much more zonate, though at times the two species are not easily distinguished. One is here forcibly reminded of *Pycnoporus cinnabarinus* and *Pycnoporus sanguineus*, which exhibit much the same relations, indicating that the effect of tropical conditions may be to produce a thinner, more expanded and more zonate sporophore.

Specimens are at hand from Florida, *C. G. Lloyd;* Bahamas, *Mrs. Britton 773, 847;* Porto Rico, *Wilson 294;* Hayti, *Nash 234, 240;* Cuba, *Underwood & Earle 1522, Hamilton;* Mexico, *Egeling;* Nicaragua, *Smith;* British Guiana, *Millspaugh 13529;* Honduras, *Wilson 411;* Yucatan, *Millspaugh 57800;* Colombia, *Baker.*

SPECIES INQUIRENDAE

Daedalea subtomentosa Schw. Syn. Fung. Car. 68. 1818. Described from North Carolina material as follows:

"D. minor gibbosa, zonis elevatis subtomentosis albida, sinubus poriformibus angustis albis et pallidis. Passim. Species non valde distincta. Pileus glaber tuberculosus."

This is very probably another synonym of *A. confragosus*, but I have not been able to find type material. Even Schweinitz himself says that it is not a very distinct species.

Irpex maximus Mont. Ann. Sci. Nat. II. Bot. **8**: 364. 1837. Syll. Crypt. 174. 1856. *Polyporus labyrinthicus* Mont. Cuba, 406. 1842 (not *P. labyrinthicus* Fr. Elench. 83. 1828).

This species was described from material collected by Ramon de la Sagra on the trunks of trees in Cuba. Montagne's earlier description is as follows:

"Pileo coriaceo tenui reniformi plano-convexo velutino marginem versus repandum acutum concentrice sulcato demum basi glabrescenti subradiato dentibusque confertis acutis pubescentibus ochroleucis."

"Pileus 8 poll. transversim latus, 6 poll. longus, vix lineam semis cum dentibus crassus, subtus vel ad marginem prolifer. Eximie distincta species nec cum ulla alia confundenda."

Before the appearance of his work on Cuban cryptogams, Montagne seems to have changed his mind regarding the distinctness of this species and in that work adopts Fries' name and description for his plant.

Lenzites tenuis Lév. Ann. Sci. Nat. III. Bot. **5**: 122. 1846. Collected on trunks in Guadeloupe and thus described:

"Pileo subflabellato coriaceo azono nudo pallide ochroleuco postice fuscescente margine acutissimo lobato quandoque prolifero, lamellis rectis dichotomis anastomosantibus acie acutis concoloribus."

"Cette espèce est voisine du *Lenzites polita*, dont elle diffère par le peu d'épaisseur du chapeau et la ténuité des lames; la marge, qui est très mince, donne quelquefois naissance à d'autres petits chapeaux. Il atteint de 8 à 10 centimètres dans son plus grand diamètre."

This species resembles thin forms of *Agaricus confragosus*, but more material is needed to determine its exact relations.

Daedalea violacea Lév. Ann. Sci. Nat. III. Bot. **5**: 142. 1846. Described from specimens collected on trunks in Cuba as follows:

"Pileo coriaceo applanato semi-orbiculari nudo inaequabili zonato lurido e basi ad marginem patentem acutum lobulatum fibroso-radiato, sinubus minutissimis anastomosantibus violaceis."

"Chapeau coriace, large de 12 à 14 centimètres, épais de 5 millimètres, à surface zonée, nue, inégale, marquée de stries qui naissent de la base et s'étendent à la marge. Cette espèce de *Daedalea* rappelle par la ténuité des sinus ceux de l'*Hymenogramme javensis*, et présente sur les deux faces une couleur violette semblable à celle du *Polyporus Auberianus*. On ne peut cepandant confondre ce *Daedalea*, quoique du même pays, avec ce dernier, dont les pores sont ronds."

Daedalea plumbea Lév. Ann. Sci. Nat. III. Bot. **5**: 302. 1846. Described from plants collected on trunks in New York as follows:

"Pileo sessili reniformi vel semi-orbiculari coriaceo depresso zonato inaequabili nudo plumbeo, sinubus lamellosis labyrinthiformibus laxis obtusis fuscis, contextu concolori."

"Chapeau coriace, semi-orbiculaire ou réniforme, large quelquefois de 2 décimètres: sa marge tend constamment à se relever. La surface est nue, tuberculeuse,d'un gris plombé; les sinus sont àpeu près semblables à ceux du *Daedalea quercina*, mais d'une couleur obscure, ainsi que le parenchyme du chapeau."

The above description indicates that the author was possibly dealing with old and darkened specimens of *Agaricus quercinus*.

Daedalea puberula B. & C. Grevillea **1**: 67. 1872. Described from plants collected in Pennsylvania by Michener as follows:

"Pileo molli-suberoso, irregulari, dimidiato, hic illic tuberculoso, puberulo, ochraceo; margine tenui: poris parvis demum sinuatis."

"About 4 inches across; irregular, corky, of a soft substance, which is slightly zoned, attached behind, and more or less decurrent, even, with the exception of a few obtuse, tubercular, elevations, finely pubescent; ochraceous; pores about 1/50 inch across, sinuated; of the same colour as the pileus."

LENZITES Fr. Gen. Hymen. 10. 1836

This genus, dedicated to Lenz, was described by Fries as follows:

"Lamellae coriaceae, radiantes, nunc simplices, nunc poroso-anastomosantes, acie compaginatae; dissepimento pileo floccoso."

Fries lists only three species, *L. betulina*, *L. abietina* and *L. heteromorpha*, the first of which we consider the type. As at present limited, the genus contains only two North American species, one very abundant in the United States and Canada and the other known only from Cuba.

Synopsis of the North American species

Surface of the pileus conspicuously tomentose.	1. *L. betulina*.
Surface of the pileus finely pubescent.	2. *L. cubensis*.

1. LENZITES BETULINA (L.) Fr.

Agaricus betulinus L. Sp. Pl. 1176. 1753.—Sowerby, Eng. Fung. *pl. 182*. 1799.

Daedalea betulina Rebentisch, Prodr. Fl. Neom. 371. 1804.—Fr. Obs. **1**: 104. 1815.

Lenzites betulina Fr. Gen. Hymen. 10. 1836.

Linnaeus describes this species as "Agaricus acaulis coriaceus villosus: margine obtuso, lamellis ramosis anastomosantibus." "Fl. Suec. 1085. Habitat in Betulis." Later botanists also described it under various other names. The plant is exceedingly common and is so well known as to need no description, being found in abundance on old stumps, fallen branches and other

forms of deciduous wood throughout the north temperate zone. Fries says in his Epicrisis that it is confined to deciduous wood, but Peck states that it occurs also on that of evergreen trees. I have never seen it growing upon coniferous wood, but many of our fungi that normally occur upon deciduous wood have been known to attack that of dead conifers in the vicinity, or, in barren regions, when hard pressed for food.

The following specimens are listed in order to give some idea of the range of this species: Finland, *Karsten;* Germany, *Sydow;* Massachusetts, *Porter;* New York, *Britton, Murrill;* New Jersey, *Ellis; Mrs. Lobenstine;* Pennsylvania, *Barbour;* Virginia, *Murrill;* Tennessee, *Murrill 636;* South Carolina, *Ravenel;* Alabama, *Earle & Baker;* Missouri, *Demetrio;* Kansas, *Bartholomew;* Michigan, *Hicks;* Wisconsin, *Baker;* Montana, *Mrs. Fitch.* Many other collections and most of the published exsiccati contain good examples of this fungus.

2. LENZITES CUBENSIS B. & C.

Lenzites cubensis B. & C. Jour. Linn. Soc. Bot. **10**: 303. 1868.

Described from plants collected by Wright in Cuba on dead wood as follows:

"Pileo duro ligneo dimidiato subvelutino cervino zonato rugoso; stipite nullo vel brevissimo; lamellis repetite furcatis crenatis vel crispis concoloribus latioribus."

"Pileus 2½ inches broad and 1½ inches long."

Nothing is known of this species beyond the above description and a few type specimens still to be seen at Kew and Paris. It appears, however, to belong with our common species, *L. betulina*, from which it may at once be distinguished by its almost glabrous surface. It is no doubt rare and possibly confined to the higher altitudes of Cuba.

SPECIES INQUIRENDAE

Lenzites Berkeleyi Lév. Ann. Sci. Nat. III. Bot. **5**: 122. 1846. Based upon plants collected by Ménand in New York. *Daedalea betulina velutina* Berk. (Ann. Mag. Nat. Hist. **3**: 381. 1839) is cited as a synonym and doubtless accounts for the specific name adopted. Berkeley's description is as follows:

"Pileus hard, sessile, dimidiate, lobed, deeply zoned, tawny, velvety. Gills rather thick."

"New Orleans and other parts of North America. Hooker Herbarium. The pileus is by no means tomentose, but clothed with very short close velvety pubescence. Vertex sometimes lengthened out into a sort of stem. *Thelephora lobata* varies in the same way."

Léveillé's description of the species is as follows:

"Pileo coriaceo flexili subreniformi sessili hirsuto fulvo zonis confertis prominentibus notato, lamellis latissimis distantibus acie integris ochroleucis."

"Chapeau presque réniforme, coriace, large de 4 à 8 centimètres, d'une belle couleur fauve, avec des zones saillantes et assez rapprochées; les lames sont très larges, comparées à l'épaisseur du chapeau, jaunes, à marge tranchante et entière."

In their Commentary on Schweinitz' Synopsis, Berkeley and Curtis determine no. 486, "*D. an gibbosa*, ?" as *Lenzites Berkeleyi* Lév.

CERRENA S. F. Gray, Nat. Arr. Brit. Pl. **1**: 649. 1821

This genus was founded upon *Cerrena cinerea* (Pers.), a single species. The very brief generic description, "Stem distinct: cap semicircular," is followed by the citation of two synonyms and a short description of the species. Although the descriptions are unsatisfactory, the citations point very plainly to a definite and well-known species as the type of the genus.

CERRENA UNICOLOR (Bull.) Murrill

Boletus unicolor Bull. Herb. France, *pl. 408*. 1788. *pl. 501*. 1791. — Bolt. Hist. Fung. Halifax, Append. 163. *pl. 163*. 1791. — Sowerby, Eng. Fung. *pl. 325*. 1801.
Boletus decipiens Schrad. Spic. 169. 1794.
Sistotrema cinereum Pers. Syn. 551. 1801.
Daedalea unicolor Fr. Syst. **1**: 336. 1821.
Phyllodontia Magnusii Karst. Hedw. **22**: 163. 1883.
Cerrena unicolor Murrill, Jour. Myc. **9**: 91. 1903.

This species was first described from France by Bulliard. The ordinary form has been known for a long time, but European mycologists were considerably puzzled in 1876 by the discovery of a peculiar hydnoid form on a birch stick in the fern house at

Berlin. Specimens were sent to various mycologists and one of them was described by Karsten as *Phyllodontia Magnusii*, in honor of the discoverer, and became the type of a new genus. Hennings later found specimens of the same form in the same place, and traced their connection with *Daedalea unicolor*.

Cerrena unicolor is extremely abundant on stumps, logs and various other forms of decaying deciduous wood in the north temperate zone. New pilei form early in the season from the old ones, the surface being at first light yellowish-white and very hairy, becoming gray with age. The tubes are porous in very young stages, but soon unite into complicated labyrinthiform channels and later split up into teeth resembling those found in the *Hydnaceae*. No choice beyond deciduous wood is apparent as regards host; oak, beech, poplar, walnut, hickory, birch, elm, apple and various other broad-leaved trees serving as food when dead or decayed.

Specimens have been examined in all the published exsiccati that pretend to exhibit northern plants of this group. From the following list a good idea may be gained of the wide range of the species: Russia, *Jaczewski;* Sweden, *Romell;* Germany, *Magnus;* Austria, *Bresadola;* France, *Patouillard;* Newfoundland, *Waghorne;* Maine, *Ellis*; New Hampshire, *Gerard, Blake, Jeffries;* Massachusetts, *Miss Minns;* New York, *Shear, Ellis, Underwood, Earle, Peck, Murrill;* New Jersey, *Ellis, Underwood, Earle, Murrill;* Pennsylvania, *Herbst, Stevenson, Small, Banker;* Delaware, *Commons;* West Virginia, *Nuttall;* Virginia, *Murrill 252;* Ohio, *Morgan, Lloyd;* Illinois, *Mrs. Roy;* Missouri, *Demetrio;* Kansas, *Cragin;* Michigan, *Pieters, Wood;* Iowa, *Holway*.

SPECIES INQUIRENDAE

Daedalea tortuosa Cragin, Bull. Washburn Lab. Nat. Hist. 1: 26. 1884. Jour. Myc. 1: 28. 1885. Described from specimens collected on rotten logs at Topeka, Kansas, as follows: "Pilei dimidiate, convex, often imbricated and confluent, between corky and woody, strigose-roughened, pale yellowish-brown, becoming smoother and paler, internally concolorous, zonate, one-twelfth to one-eighth of an inch thick, usually once or twice sulcate near the acute, minutely repand, ferruginous-brown margin.

(Margin sometimes concolorous.) Hymenium pale cinnamon-brown, generally effused at the base and abruptly sub-porous at the margin. Sinuses labyrinthiform, flexuose, intricate, torn and toothed; very similar to those of *D. unicolor* Fr., except in color and much larger size. The largest single pilei observed measure about two inches in length by three in breadth."

Authentic specimens of this plant have not been seen, but there appears to be little in the description to distinguish it from forms of *Cerrena unicolor*.

FAVOLUS Beauv. Fl. Owar. 1: 1. *pl. 1.* 1805.

This genus was founded upon a single species, *F. hirtus* Beauv., which, although commonly known under the name of *Hexagona hirta*, recalls the true honeycomb-like structure of the hymenium which was originally the distinguishing feature of the genus *Favolus*. The genera *Hexagona* and *Favolus*, both monotypic in origin, were interchanged by Fries because the species were unfamiliar to him and they have been incorrectly used ever since.

In the *Systema*, Fries followed Beauvois and included *Hexagona* under the subgenus *Favolus* of *Polyporus*. In the *Epicrisis*, Fries includes *F. hirtus*, Beauvois' type, in the genus *Hexagona* and follows it with *H. Mori*, Pollini's type. He then begins his genus *Favolus* with *F. europaeus*, a synonym of *H. Mori*.

The plants of this genus are not well known, few as they are. The two species ordinarily collected in North America are confined to the tropics, a comparatively unworked region. There is little difference either in the abundance or the distribution of these species, but they may be easily distinguished by color and markings. Both species vary rather remarkably in the size of their pores. Berkeley frequently commented upon it in his writings and his varieties testify to the fact. There appears to be absolutely no other different character accompanying this difference in pore measurement. A large collection of specimens is needed in order to guess at the cause of this variation, which at times amounts to two or three diameters.

Synopsis of the North American species

Surface marked with white and light-brown zones.	1. *F. tenuis.*
Surface variegated with dark-brown and purple zones.	2. *F. variegata.*

1. **Favolus tenuis** (Hook.)

Boletus reticulatus Hook. in Kunth, Synopsis **1**: (9). 1822. Not *B. reticulatus* Schaeff.

Boletus tenuis Hook. in Kunth, Synopsis **1**: (10). 1822.

Polyporus polygrammus Mont. Ann. Sci. Nat. II. Bot. **8**: 365. 1837.

Hexagona tenuis Fr. Epicr. 498. 1838.

Hexagona polygramma Fr. Epicr. 497. 1838. — Mont. Pl. Cell. Cuba 379. *pl. 14. f. 3.* 1842.

Hexagona favoloides Peck, Bull. Torrey Club **10**: 73. 1883.

This species is found in the Linnaean herbarium marked *Boletus favus*, but not by Linnaeus nor with his sanction. It was first described by Hooker from plants collected in the Andes between Popayan and Almaguer by Humboldt, under the name of *Boletus reticulatus*. Following this species on the next page is *Boletus tenuis*, described as differing from the preceding in its paler, smooth, dimidiate pileus and empty pores. According to Klotzsch, *Boletus reticulatus* is only a monstrous form of *Boletus tenuis* with the pores spongy-stuffed and the pileus orbicular, fixed at the center and more than usually reticulate-rugose on the surface. This view is strengthened by the fact, which Hooker states, that the two species were found growing together.

In reviewing Klotzsch's work in 1839, Berkeley lists *Boletus reticulatus* as synonymous with *Boletus tenuis* and enlarges Hooker's description from the original specimens, explaining that the monstrous form in question was caused by the accidental reversal of the log or branch upon which it grew and that the spongy-stuffed pores were due to the beginning of a new pileus, while the abnormal reticulations on the surface were caused by a new hymenium beginning to form on the old pileus. This leaves practically no doubt as to the identity of the two species; but since the first name is antedated by one of Schaeffer's, *Boletus tenuis* would hold for our plants in spite of the doubt.

The Cuban plant, finely described and figured by Montagne, appears in the figure to have larger pores than plants from elsewhere, but the type collections do not indicate that it is specifically different.

Peck's species, described from plants collected by J. J. Brown on the Roatan Islands off the coast of Honduras, is well represented by a number of specimens collected recently in Honduras by Wilson, and I do not find it distinct in its mature stages from Hooker's plant. The fresh young sporophores have a strong resemblance, as Peck says, to forms of *Agaricus confragosus*.

This species is fairly common and, in some localities, rather abundant in tropical America. Among the plants examined the following may be mentioned: Guayaquil, *Lagerheim;* Colombia, *Baker;* Nicaragua, *C. L. Smith, Shimek;* Honduras, *Wilson 4, 410, 449;* Mexico, *C. L. Smith;* Cuba, *Wright 315, Wilson.*

2. **Favolus variegatus** (Berk.)

Hexagona variegata Berk. Ann. Mag. Nat. Hist. II. **9**: 196. 1852. Proc. Amer. Acad. Arts & Sci. **4**: 122. 1858.

This species was first described from plants collected in San Domingo, as follows:

"Pileo tenui coriaceo dimidiato rugoso crebri-zonato multicolori velutino; hymenio umbrino poris mediis."

It is a very showy plant and rarely escapes the collector, being large and much expanded, with surface brilliantly marked with variegated zones of red and brown tints. The typical form occurs in southern Florida and the West Indies in fair quantity, while it ranges either in this form or in one with smaller pores, called var. *membranacea* at Kew, to various parts of Central America and into South America. The well-known tendency of species in this genus to vary in pore measurement prevents me from founding a species on the variety just mentioned. Possibly when more is known of the plants in the field, such a separation may be found desirable.

Specimens are at hand from Florida, *Calkins, Small & Nash, Small & Carter;* Costa Rica, *Endres;* Nicaragua, *Wright, C. L. Smith;* Mexico, *Egeling;* Colombia, *Baker;* Brazil, *Glaziou, Balanza;* Peru, *Pearce;* Bolivia, *Bang.*

SPECIES INQUIRENDAE

Hexagona papyracea Berk. Ann. Mag. Nat. Hist. **10**: Suppl. 379. 1843. Described from some unknown locality; possibly from

Brazil. The pileus is said to be nine inches broad, five inches long and as thin as paper, resembling most a species gathered by Schomburgk in Brazil communicated by Berkeley to Montagne under the name of *Hexagona variegata*, but considered by him only a non-setose state of his *Hexagona aculeata*.

A specimen in the herbarium of the Agricultural Department at Washington, collected by Wright in Nicaragua and labeled *Hexagona papyracea* Berk., differs from plants ordinarily called *Hexagona variegata* in its thinner, flexible pileus and smaller, stag-colored pores. There is such a specimen also in the herbarium of the New York Botanical Garden collected in the Peruvian Andes by Pearce and marked *Hexagona variegata* Berk. Both of these specimens, however, are only var. *membranacea* of *Hexagona variegata*, as type plants at Kew show.

Hexagona cingulata Lév. Ann. Sci. Nat. III. Bot. **2**: 200. 1844. Described from material collected in Hispaniola as follows:

"Pileo coriaceo reniformi membranaceo nudo zonato pallide cinereo nitente, alveolis mediis fuscis e rotundo hexagonis intus cinereis."

"Petite espèce réniforme, nue, zonée, de couleur pâle cendrée, et brillante, large de 2 à 4 centimètres; ses alvéoles sont parfaitement régulières, de moyenne grandeur, fauves, obtuses à la marge, et cendrées a l'intérieur."

From the above description this species can hardly be different from *Favolus tenuis* (Hook.).

Hexagona leprosa Fr. Nov. Symb. 101. 1851. Described as follows:

"Pileo suberoso crasso pulvinato laevigato leproso-pruinoso umbrino, alveolis profundis amplis acutis fusco-umbrinis, intus nudis."

"In Insula San Jan, Indiae occidentalis. Oersted."

Plants of this name at Kew are very distinct from other North American species, being much thicker and having much longer tubes, reminding one somewhat of a wasp's nest. Further study is necessary before their exact relations are known.

Hexagona unicolor Fr. Nov. Symb. 101. 1851. Described from "America calidiori" as follows:

"*H. unicolor*, dilute ferruginea, pileo coriaceo rigido subflexili applanato concentrice sulcato glabro, alveolis mediis vadosis angulatis."

The following notes are appended to the description:

"Pileus dimidiatus, sessilis, peltato-adnatus, reniformis, 2 unc. circiter transversim latus, passim plures imbricati, dilute ferrugineus, non priorum instar incrassatus, sed tenuis applanatus subflexilis, rigescens tamen, sulcis concentricis concoloribus exaratus (nec a basi radiato-rugosus), glaber. Margo acutus, passim incisus, concolor. Contextus floccosus, dilute ferrugineus. Pori medii, regulares, 4–6-goni, obtusiusculi, dilute cinnamomei.—Inter fungos Americanos inveni, sed locum specialem ignoro."

The type of the species I have not seen, but the description indicates that it is not far from *Favolus tenuis* (Hook.). This opinion is strengthened by comparing *Hexagona fasciata* Berk., which Fries says is very near his *Hexagona unicolor*.

Certain resupinate forms, such as *Hexagona carbonaria* B. & C. (Grevillea **1**: 68. 1872), *Hexagona pallens* Sacc. (Misc. Myc. **2**: 14. 1884) and *Hexagona vittata* Ell. & Macbride (Bull. Iowa Lab. Nat. Hist. **4**: 68. 1896), described from South Carolina, Mexico and Nicaragua respectively, hardly come within the scope of the present paper.

NEW YORK BOTANICAL GARDEN.

Further observations on Taxodium

ROLAND M. HARPER

Since the publication of my paper on *Taxodium distichum* and related species * I have spent three more seasons in the coastal plain of Georgia, where I have now had the southeastern representatives of this genus under observation every month in the year except December, and I am now able to present some additional notes on them.

One reviewer of that paper (who is among the foremost of American phytogeographers, but not a professed systematist) has expressed the opinion "that *Taxodium imbricarium* will prove to be merely an ecological variety" of *T. distichum*. If this is the case, then some hundreds if not thousands of long established and universally accepted species will have to be placed in the same category. But the fact that these two species remain perfectly distinct when cultivated in the same soil (as noted on the last page of my previous paper), not to mention the considerable difference in their geographical distribution, ought to dispose of the "ecological variety" question. From all the evidence at hand at the present writing the conclusion is irresistible that *T. imbricarium* is abundantly distinct. The only substantial argument which could be urged against the recognition of this species is the occurrence of trees intermediate (in some characters at least) between it and *T. distichum*. But these are outnumbered a hundred to one (in Georgia at least) by typical and unmistakable specimens of *T. imbricarium*, † and should not invalidate the species any more than the intermediate forms in countless other genera do.

My work will doubtless admit of some criticism from a geological standpoint, however. My attention has been called by a geologist friend to the fact that what has been passing under the

* Bull. Torrey Club **29**: 383–399. June, 1902.

† I have records of three or four hundred stations in Georgia for *T. imbricarium*, at each of which there may be from ten to several thousand individuals; while the intermediate form I have seen only about twenty times, and never more than a hundred trees at a time.

name of the Lafayette formation in Georgia and some other states is probably divisible into two or three different horizons. One of these may be the Grand Gulf, which has recently been a subject of considerable controversy.* Until geologists have settled this point among themselves I can make no satisfactory corrections in this respect. However, when the whole truth is known these two species of *Taxodium* will surely be found to stand always in some such relation to the superficial formations as I have already indicated, whether my present identification of these formations is correct or not.

It is absolutely certain though that *Taxodium distichum* grows

FIGURE 1. *Taxodium distichum* growing on Lower Oligocene rocks on right bank of Flint River, Sumter County. July 5, 1902.

directly on the underlying rocks of the coastal plain, as I had excellent opportunity to observe on the Flint River east of Americus in July, 1902, when the water was unusually low for that time of year (see *figure 1*). And similar conditions have doubtless existed for thousands of years, for according to Bibbins † fos-

* For a discussion of the nomenclature, relationships and distribution of this formation the reader is referred to the following papers in Science (new series), all entitled "The Grand Gulf Formation": — Smith & Aldrich, 16: 835–837. November 21, 1902; Dall, 16: 946, 947. December 12, 1902; Smith & Aldrich, 18: 20–26. July 3, 1903; Dall, 18: 83–85. July 17, 1903; Hilgard, 18: 180–182. August 7, 1903.—See also Dall, Trans. Wagner Free Inst. Sci. 3: 1561–1564. 1903.

† Plant World 1: 164–166. August, 1898.

sil cypress stumps have been found on the shores of Chesapeake Bay with their roots imbedded in Cretaceous strata. It was at first supposed that the stumps themselves were of Cretaceous age, but subsequent investigations by the same author and Dr. Hollick have shown that the trees grew in Pleistocene times, sending their roots down into the Cretaceous strata on which they stood, and the stumps have been preserved *in situ*.

The actual contact of *T. imbricarium* with the Lafayette formation (or what passes for it) has not yet been observed, and could hardly be without having special excavations made for the purpose, but I have often seen this formation exposed (particularly in railroad cuts) within a few yards of colonies of this tree.

The relations of the two species under consideration to the geological formations are well illustrated at Bull Head Bluff on the Satilla River in Camden County, Georgia, which I visited in August, 1902. The bluff is about eight feet high, and exhibits the following section, in descending order: Two feet of Columbia sand, five feet of reddish clay (Lafayette?), and about a foot of stiff bluish clay (doubtless Tertiary, but exact age unknown). Typical *Taxodium distichum* grows here along the water's edge, below the Lafayette, while a hundred yards or so away from the river equally typical *T. imbricarium* flourishes in moist pine-barrens.

Ecologists have had a good deal to say recently about drained and undrained swamps, and the remarkable differences in their flora. If they would examine the habitats of the two taxodiums they would find that *T. distichum* always grows in "drained" swamps, and *T. imbricarium* usually in ponds, which are of course "undrained." In the Southeastern States, as in other parts of the country, there are very few species common to both habitats. In their relation to limestone the taxodiums are equally distinct, *T. distichum* being essentially a limestone-loving species and *T. imbricarium* just the opposite. (The latter often, perhaps always, grows over limestone, but never in contact with it, some more recent formation always intervening.)

There are also some additional morphological characters which I overlooked before, by which the two species under consideration may be distinguished. In Washington in the spring of 1902 my

attention was called by Dr. J. N. Rose to a difference in the bark of cultivated specimens, that of *T. imbricarium* (cultivated there under the name of *Glyptostrobus*) being considerably thicker and more coarsely ridged than that of *T. distichum*. On my return to the field I soon found that the same was a constant and well-defined character of the wild trees, and it has since been of considerable assistance to me in studying their distribution, particularly in the winter months when the leaves were fallen.

There is also a marked difference in the knees, those of *T. imbricarium* being short and rounded, often almost hemispherical, while those of *T. distichum* are usually slender and acute, sometimes reaching a height of six feet (in the Suwannee River in Clinch County, for instance). The latter species seems to produce knees much more abundantly, Elliott's opinion to the contrary notwithstanding. In both species the height of the knees and that of the enlarged base of the trunk usually indicates the maximum level of the water in which they grow,* with the exceptions that in deep ponds the knees of *T. imbricarium* are entirely submerged or perhaps wanting, and in many creek swamps those of *T. distichum* are very small and do not grow as high as the enlargement of the trunk. In May, 1904, I saw in the pine-barrens near Douglas, Georgia, in a place which had once been a small mill-pond, some saplings of *T. imbricarium* with trunks perceptibly enlarged up to about six feet from the ground, which was just the height of the dam. In cultivation, where they are never inundated, it has been my observation that each species produces a slight but characteristic enlargement of the trunk. (The specimens on the grounds of the Smithsonian Institution and Department of Agriculture in Washington are good examples.) This does not agree with the recently published observations of Dr. S. M. Coulter.† In wet pine-barrens, where there is likewise no inundation, the enlargement of the base of *T. imbricarium*, though insignificant compared with what it is in ponds, is always present (see *figure 4*). In any one stream or pond the enlarged bases are all the same height, regardless of the size of the tree.

* This was noted in the case of *T. distichum* by Dickeson and Brown in a paper on the cypress timber of Mississippi and Louisiana, in 1848 (Am. Jour. Sci. II. **5**: 15–22).

† Rep. Mo. Bot. Gard. **15**: 59. *pl. 15–18*. 1904.

FIGURE 2. *Taxodium imbricarium* in a shallow pine-barren pond in Coffee County. July 24, 1902. Note the rounded knees and the very abrupt enlargement of the trunks. The water-level in this pond probably does not vary more than a foot or two.

FIGURE 3. *Taxodium imbricarium* in Twenty Mile Creek, Coffee County. Sept. 24, 1900. Note the greatly enlarged base of the trunk and its broad rounded ridges.

FIGURE 4. *Taxodium imbricarium* in wet pine-barrens near Douglas, Coffee County. Base of trunk not conspicuously enlarged. Several specimens of *Pinus Elliottii* in background. Feb. 3, 1904.

An examination last winter of some specimens of *T. imbricarium* which had been felled, showed the structure of the base of the trunk in cross-section. The broad longitudinal ridges of wood become pressed against each other as they grow, closing the sinuses between them (as shown in the accompanying diagrams), while in *T. distichum* the sinuses are open and rounded and the ridges rather sharp. Ericaceous shrubs (such as *Pieris nitida* and *Leucothoe racemosa*), growing close to the base of such a tree, often have their stems caught in the embrace of the swelling ridges and then appear as if growing out of the *Taxodium* above the ground. The climbing habit of *Pieris phillyreaefolia* * may have originated in some such way. In both species the base seems to be always hollow in old specimens, and knees often grow inside it.

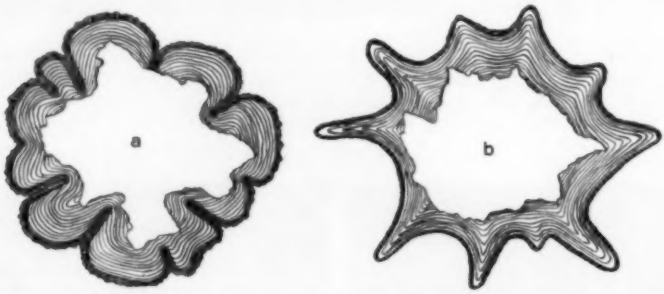


FIGURE 5. Ideal cross-sections of hollow enlarged base of trunk of *Taxodium imbricarium* (*a*) and *T. distichum* (*b*). (The annual rings in reality would be ten to fifty times as numerous as they are shown here.)

Another distinction (though rather a subtle one) between these two species is that in *T. distichum* the trunk is straight but not always erect, while in *T. imbricarium* it is erect but not always straight.

The following additional notes on the distribution of the two southeastern species may be of interest.

TAXODIUM DISTICHUM

In Georgia the inland limit of this species reaches the fall-line at the eastern border of the state, but diverges widely from it westward, following approximately the outcrop of the Eocene forma-

* See Torreya 3: 21, 22. February, 1903.

tions. On the Savannah River it ascends just to Augusta; on the Ogeechee and its tributaries it terminates somewhere between Louisville in Jefferson County and the Augusta Southern R. R. in Glascock; on the Oconee it is common in Laurens and Montgomery Counties, but terminates at or near the Central R. R. bridge in Washington and Wilkinson; on the Ocmulgee it ascends to Twiggs and Houston Counties; on the Flint to Macon County (I am told), but not quite to the twin cities of Oglethorpe and Montezuma; and on the Chattahoochee I have seen it only in Early County near Saffold, though it grows in low grounds near the river at Columbia, Alabama, several miles farther up. On the smaller rivers which rise below the fall line (and are therefore not muddy), it ascends the Satilla to Bull Head Bluff or beyond, the St. Mary's nearly to its head at the southeastern corner of Okefinokee Swamp, the Withlacoochee to Lowndes County, and the Ochlocknee to Moultrie. (It is mostly in some of these smaller rivers, such as the Canoochee, Ohoopee, Satilla, Suwannee, Allapaha and Withlacoochee, that the puzzling intermediate forms occur.) Near the coast, in the counties of Glynn and Camden in Georgia and Nassau in Florida, this species occurs away from the rivers in numerous extensive swamps, the character of whose flora points strongly to the absence of the Lafayette formation.

Its most frequent associates in Georgia are *Hicoria aquatica*, *Planera aquatica*, and *Nyssa aquatica* (*N. uniflora*).

Dr. R. Ellsworth Call* has published some interesting notes on the occurrence of *Taxodium distichum* in eastern Arkansas, in which he says among other things: "From the top of Crowley's Ridge, looking either to the east or the west, at those points which command the valleys of the St. Francis and the Cache, the cypress areas can be readily made out by the observer. The tops of the giant trees tower far above the heads of the intervening forests and give one the location of the swamps for hundreds of square miles."

Some outlying stations for this species in the Edwards Plateau of Texas (which includes Kerrville, mentioned in my previous paper) have been described by Hill and Vaughan,† who say in part: "The occurrence of the cypress is a peculiar anomaly. This tree,

* Rep. Geol. Surv. Ark. 1889[2]: 198–200. 1891.

† Ann. Rep. U. S. Geol. Surv. 18[2]: 210, 211. 1898.

which ordinarily grows only in the swamps and bayous of the low subcoastal regions, attains an enormous size at the edge of the deeper holes near the heads of permanent water of the Pedernales . . . and other streams. These localities are at altitudes from 1,000 to 1,750 feet above the sea, hundreds of miles west of the great cypress swamps of the eastern tier of Texan counties, with which they have no possible continuity." (See also Bray, U. S. Dept. Agric., Bureau of Forestry Bull. 47: 53; 49: 16. 1904.)

TAXODIUM IMBRICARIUM

This species is very abundant in the coastal plain of Georgia, where I have seen it in every county in which Oligocene or later rocks occur, *i. e.*, from the inland edge of the pine-barrens to Florida and the coast. On the way to Georgia in 1903 I saw it in Moore County, N. C., near the fall-line,* and in Hampton County, S. C. It is common in Nassau and Baker Counties in Florida, but no data are yet available as to its southern limit in that state.

Outside of the pine-barrens in Georgia there are several outlying stations for it, where it grows in shallow ponds. These have been noted as follows: In Richmond County between Adam and Adventure, in Jefferson near Wadley, in Washington near Sandersville, in Taylor near Reynolds, and in Terrell between Bronwood and Dawson. All these localities, according to the best information at present obtainable, seem to be underlaid by rocks of the Claibornian division of the Eocene. The Taylor County station is of interest as being the farthest inland, and most remote from the pine-barrens. At this point the *Taxodium* is in imminent danger of extinction, most of the trees having been already cut and used up (it being apparently the only cypress pond known in the vicinity), and few if any young trees were seen. The principal vegetation of this pond is *Liquidambar*, with a few *Crataegus aestivalis* bushes.

Toward the coast *Taxodium imbricarium* extends nearly to Brunswick, within two or three miles of salt water and not over ten miles from the open ocean. There its habitat and associates are much the same as they are fifty or a hundred miles inland.

* See Torreya 3: 123. August, 1903.

This turns out to be the predominating tree in Okefinokee Swamp, as already announced,* where it grows in all the sphagnous bogs, with *Pinus Elliottii*, ferns, *Dulichium*, *Eriophorum virginicum*, aroids, orchids, *Drosera*, *Sarracenia*, *Ilex*, ericaceous shrubs, etc., just as several other conifers do in the cedar-swamps and peat-bogs of the North. It is said to attain enormous dimen-

FIGURE 6. View of Cane Water Pond, Decatur County, showing a group of saplings of *Taxodium imbricarium* in center, and branches of two older trees at the sides. Aug. 6, 1903. Note the gradually tapering trunks of the saplings (doubtless due to great variations in water-level), and the erect leaf-bearing branchlets on all the trees.

sions there, but I did not penetrate far enough into the heavily timbered portions of the swamp to verify this. Elsewhere in Georgia it is nearly always associated with *Pinus Elliottii*, and commonly with *Pinus serotina*, *Dichromena latifolia*, *Ilex myrtifolia*, *Magnolia glauca*, *Hypericum fasciculatum*, *Nyssa biflora*, *Oxypolis filiformis* and *Pinckneya pubens*.

The natives in Georgia do not seem usually to make any dis-

* See Torreya 2: 157. Oct. 1902; and Science II. 17: 508. 27 March, 1903.

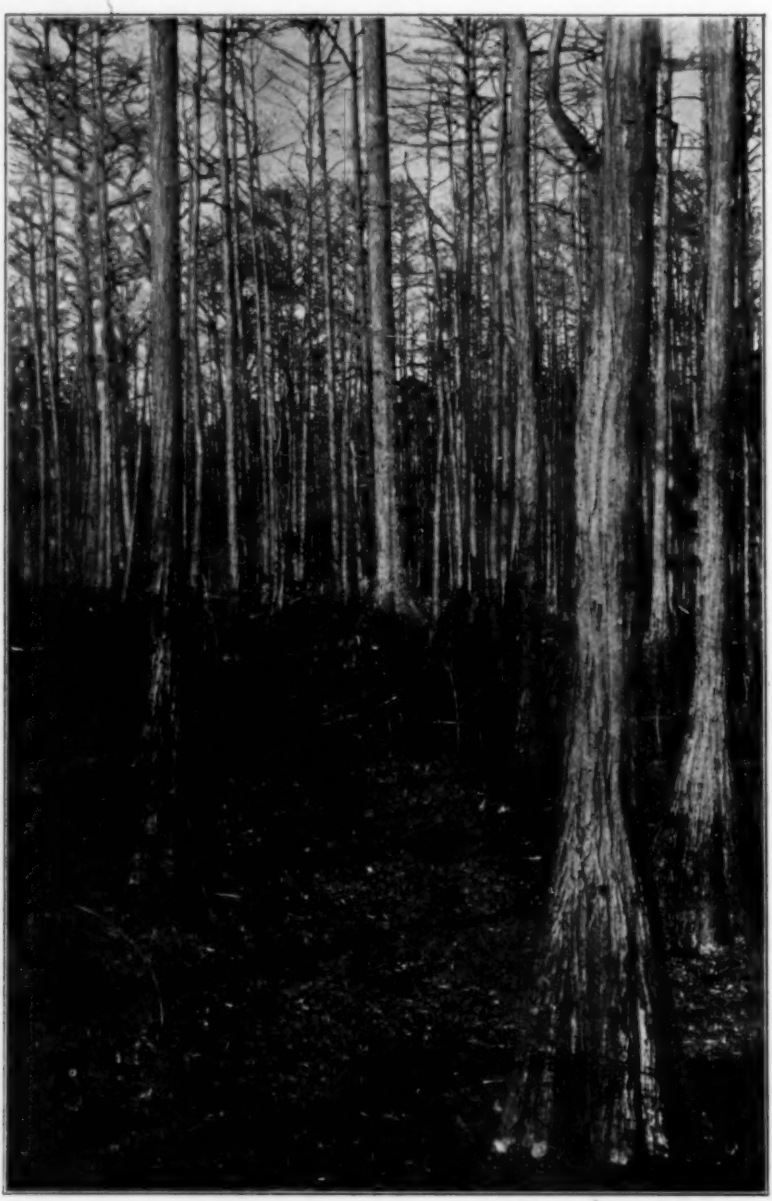


FIGURE 7. Nearly pure association of *Taxodium imbricarium* in a shallow pond (dry at the time the photograph was taken) about three miles east of Valdosta, Lowndes County. Feb. 13, 1904. Note the rather coarsely ridged bark, the erect trunks, and their enlarged bases all of the same height. One or two saplings of *Pinus Elliottii* are visible.

tinction between the two species of cypress. Lumbermen recognize several varieties, such as white, black and red cypress, based on the appearance of the wood, but as they do not correlate these with any leaf or bark characters, I cannot see but what all these names apply to *T. distichum*, which furnishes practically all the cypress lumber on the market. *T. imbricarium* is used to some extent for posts, telegraph poles, and crossties, but just why it is not used for lumber I have not satisfactorily ascertained. Elaborate preparations were made several years ago for getting this species out of Okefinokee Swamp and sawing it up, but for various reasons this enterprise was abandoned after it had been in operation a short time. The danger which thus threatened what is probably the finest body of *Taxodium imbricarium* in existence, which it has taken Nature thousands of years to accumulate, is not altogether past, but may be revived at any time. It is to be hoped that rational methods of lumbering will be universally adopted before the devastation of Okefinokee Swamp is again undertaken.

The illustrations selected to accompany this paper are mostly of *T. imbricarium*, as botanists will be more familiar with the other species, which has often been described and figured. The most conservative should now admit that for phytogeographical purposes at least it is much more desirable to regard the two species here discussed as distinct.

COLLEGE POINT, NEW YORK.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1904)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

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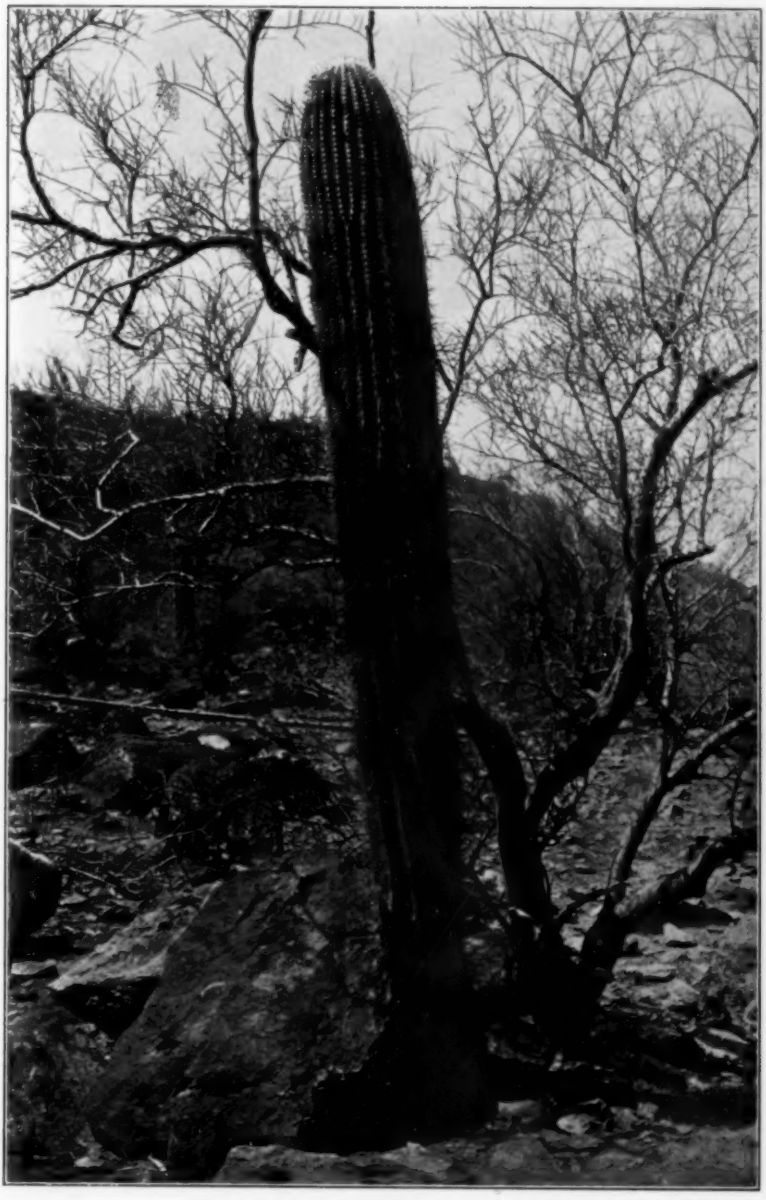

SUAHARO (CEREUS GIGANTEUS)